SCIENCE

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Volume 123, Number 3197

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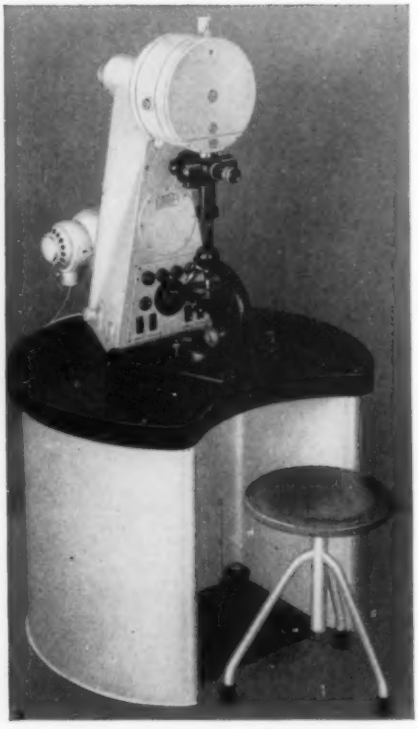

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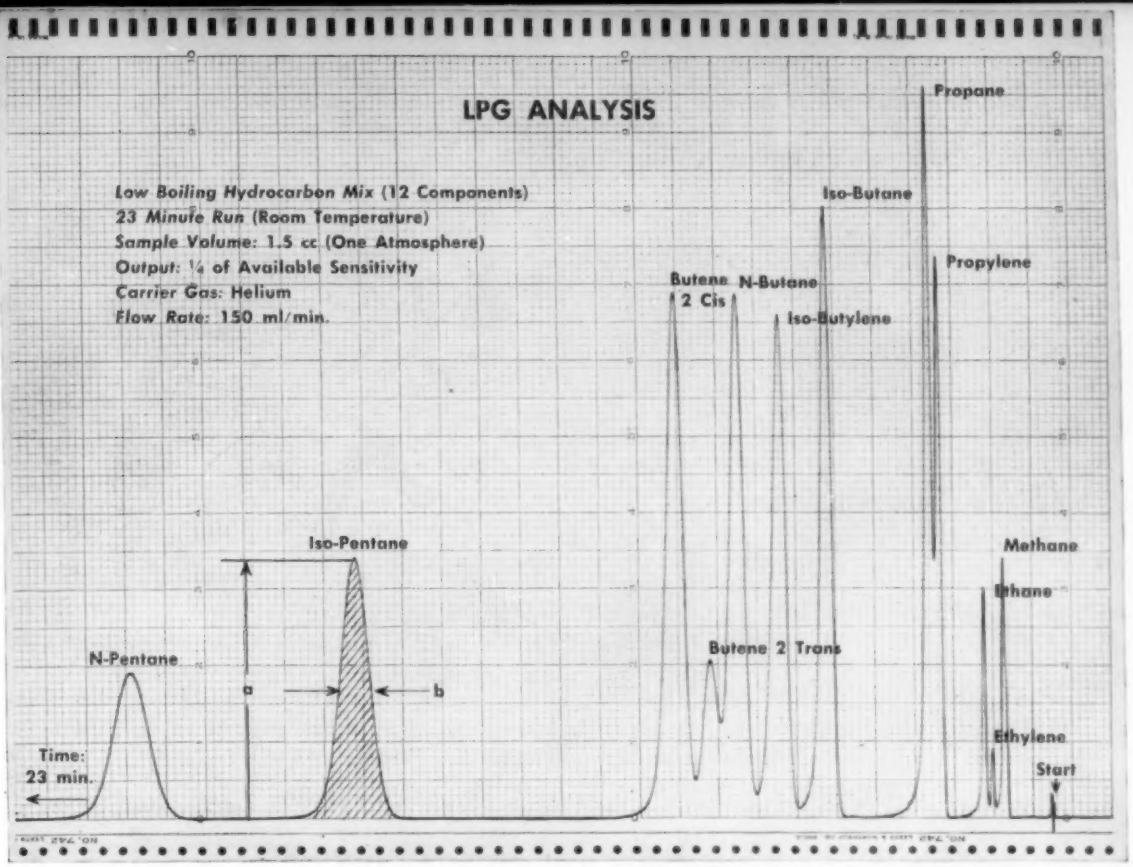

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little wanderer

It should be stated at the outset that the problem is one of nomenclature only.

When Alfred Romer delivered the manuscript of the abridgment of his comparative anatomy textbook, he confessed that he had not yet conceived a really proper name for Junior. Publication of Junior was to follow by only a few months the appearance of a Second of The Vertebrate Body, Senior, and it was felt that the two versions should have distinctly different names so as to avoid confusion.

In our exhilaration at receipt of another book from the very talented hand of Dr. Romer we advised the Author to return in peace to Harvard, inasmuch as we would put the best brains of this Publishing House at work on the task of properly naming Junior.

After a considerable interval, The Best Brains produced three suggestions:

1. that the book be called The Little Wanderer, on the grounds that it was actually the little Romer;
2. that Dr. Romer, for the purposes of this book, change his name; or
3. that we throw publishing tradition to the winds and give the book a really exciting title, maybe like *A Shorter Version of the Vertebrate Body*, with *A Shorter Version* in italic.

Anyhow, if you can think of a better title than *A Shorter Version of The Vertebrate Body* we would certainly like to hear from you, because the way things are now a lot of students are going to use up a lot of time pronouncing the name of this superb text at the bookstore. We may not be able to use your suggestions, but we surely would like to know whether anybody read this far.

Note: The Best Brains are now, and have been for some time, completely available for other Consulting Work. We can supply their last known address.

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6 April 1956, Volume 123, Number 3197

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SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of 3 March 1879.

SCIENCE is indexed in the *Reader's Guide to Periodical Literature* and in the *Industrial Arts Index.*

Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors.

Display-advertising correspondence should be addressed to SCIENCE, Room 604, 11 West 42 St., New York 36, N.Y.

Change of address: The notification should reach us 4 weeks in advance. If possible, please furnish an address stencil label from a recent issue. Be sure to give both old and new addresses, including zone numbers, if any.

Annual subscriptions: $7.50; foreign postage, $1; Canadian postage, 50¢. Single copies, 25¢. Special rates to members of the AAAS. Cable address: Advancesci, Washington.

The AAAS also publishes THE SCIENTIFIC MONTHLY.

Science in the *Saturday Review*

Scientists often and justly point out that there is not enough general understanding of what science is and of what scientists are like. They will accordingly applaud the *Saturday Review* for inaugurating, in the issue of 24 March, a monthly section on "Science and research."

In their introduction to the new section, the editors say that they have ". . . always been concerned with the creative intelligence at work—with the conditions that favor such work and with the implications of that work for society as a whole . . . we have tried to relate the world of art to the world of ideas. For some years, however, we have felt the need to give greater attention to the inquiring mind at work on the frontier of new knowledge. Such work is not infrequently an end in itself; it is not unlike art in this respect." They add that ". . . Science is intimately shaping and moving their [nonscientists'] lives from day to day. We intend to document our observation that Science is not only relevant to a creative culture but is indeed a vital part of it; and that education for the whole man must respect it."

We are in wholehearted agreement with these aims and are interested in seeing how the *Saturday Review* proposes to attain them.

The department entitled "Personality portrait" gives a well-balanced and engaging account of Laurence Snyder, president elect of the AAAS. Snyder's work in human genetics is related to the large problems of radiation damage and to improvement in the human race, but his qualities as a human being are not neglected. He is pictured, quite rightly and quite believably, as a warm and likable person. This is a welcome departure from the all-too-familiar type of article that exclaims in wonder at the accomplishments of the wizards of science.

The "Books in science" section is well done but is disappointingly short. Only three books are reviewed: James B. Conant's *The Citadel of Learning,* W. L. Oliver's *A Solomon Island Society,* and D. S. Teeple's *Atomic Energy: a Constructive Proposal.*

Under the title "The research frontier," ten distingushed scientists present short statements about research problems and approaches of importance.

Other feature articles will also be as interesting to the scientist as to the nonscientist. Harrison Brown presents a clear and readable exposition of "The case for pure research." The high status of scientists and engineers and the educational system in the U.S.S.R. are described and interpreted by John Turkevich in "The Soviet's scientific elite." A companion article is M. H. Trytten's "Why our thinkpower is dwindling," in which we find a discussion of deficiencies in the education of scientists and engineers in the United States as well as an appraisal of the possibilities for improvement.

The article that is most likely to stimulate discussion and generate controversy is the report of the Massachusetts Advisory Committee on the Polio Vaccine, in which editorial remarks are interpolated to give the background for the committee statements and to take issue with the National Foundation for Infantile Paralysis.

On the whole, the *Saturday Review* is off to a good start in its new venture with a clear, readable, but not sensationalized account of science in our society. We extend our best wishes.—G. DuS.

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6 April 1956, Volume 123, Number 3197 SCIENCE

Standards of Time and Frequency

G. M. Clemence

Until recently there was only one basic standard of time and frequency, which was used alike for all purposes both ordinary and scientific. The standard was the second, which was defined as 1/86,400 of the mean solar day. The second has now been officially redefined. It now depends not on the day but on the year, and the definition is 1/31,556,925.975 of the tropical year for 1900.0. It is now possible also to speak of an entirely different sort of basic standard of frequency, which has been made possible by the development of devices for measuring the frequency of the natural vibrations that take place in atoms and molecules; for brevity I refer to these new standards as atomic standards.

Thus we have for the first time in the history of science at least two basic standards of time existing side by side and at least three basic standards of frequency. We are not accustomed to dealing with such a profusion of standards, and in order to avoid confusion and misapprehension it is desirable to examine them in the light of our basic concepts of making measurements and to ascertain their advantages and their limitations as well as we can. The danger of confusion and misapprehension is greater because the practical determinations of time and frequency have been in the hands of a small number of astronomers. Astronomers in general, and all scientists in other disciplines, being busy with their own work, have paid little attention to the matter. Thus it now becomes the duty of the few astronomers who know something of the subject to tell what they know, and that is my purpose here.

The author is director of the *Nautical Almanac* at the U.S. Naval Observatory, Washington, D.C.

Definitions

It will be well to begin by reviewing a few fundamental definitions. Several sorts of definitions may be distinguished, and semanticists have paid considerable attention to the subject, but for our present purpose it is sufficient to speak of two kinds, operational definitions and all others. Operational definitions signify what is actually done while others do not. For example, the operational definition of a meter is the distance between two marks on a bar of platinum that is stored in a specified place in France. Another, earlier, definition of the meter is the 10 millionth part of the arc of the meridian from the north pole to the equator through Paris. Still another is 39.37 inches. When we are trying to reason as precisely as possible, it is always well to use operational definitions, and that is what I shall do for the most part. Therefore it will be no cause for astonishment if some of the definitions to follow are not found in dictionaries.

Any recurring phenomenon, the recurrences of which can be counted, is a *measure of time*. Examples are the passing of trains under the Hudson River, the ticking of a watch, the vibrations of a quartz crystal or of an atom, the meridian passage of a star, and the revolution of the moon around the earth or of the earth around the sun.

The interval between two successive recurrences is a *unit of time*.

A *clock* is any mechanism that counts such recurrences. It often serves as well to subdivide the unit of time into smaller parts. Thus our ordinary clocks subdivide the day into hours and minutes, and some special clocks subdivide the second into 1000 or 10,000 parts.

A *frequency* is the ratio between two different units of time, commonly expressed as the number of one sort of unit occurring during one unit of the other sort. Consider for example an alternating current. One unit of time is given by 1 cycle of the current. If we choose the second as the other unit, then the frequency of the current may be stated to be, for example, 60 cycles per second. While in strictness any two units of time may be made the basis for a statement of frequency, the cases that arise in practice are of only two sorts. (i) A frequency may be used as the definition of one unit of time in terms of another. For example, when we define the (old) second to be 1/86,400 of the mean solar day we might equally well say that the frequency of seconds per mean solar day is 86,400. Frequencies when used as definitions are fixed and invariable. (ii) A frequency may be used to connect an experimental unit of time with a fundamental unit. Frequencies of this sort are either *nominal* or *actual*. Thus the nominal frequency of an alternating current may be 60 cycles per second while its actual frequency may be 59.9998 cycles per second. Notice that actual frequencies must be determined by experiment and hence are necessarily affected by errors of observation.

The *rate* of a clock is the difference between its normal frequency and its actual frequency, conventionally taken in the sense nominal minus actual. For example, a seconds pendulum has a nominal frequency of 86,400 cycles per day. If its actual frequency is 86,401 cycles per day, it has a rate of −1 cycle per day. The pendulum is commonly said to have a gaining rate of 1 second per day, and this statement must be understood to be precisely equivalent to the preceding one, although in its terms it is less precise because the word *second* is used in a double sense: the unit of time given by the clock itself as well as the unit obtained by dividing the mean solar day into 86,400 parts. The rate of the clock could also be expressed by saying that it runs fast by 1 part in 86,400, or that the actual frequency is greater than the nominal by 1 in 8.64×10^4. Thus, frequencies and rates are very closely related, but they are not quite the same thing.

We notice that while a cycle of alternating current and a seconds pendulum are both measures of time they are not

both clocks. A seconds pendulum is a clock because its cycles may be immediately counted, but the same is not true of an alternating current. A mechanism may, however, be devised for counting the cycles of an alternating current, and such a mechanism is a clock. The distinction is important because clocks tell the time, or in technical language, establish the epoch—an *epoch* being any specified instant of time—while an alternating current by itself does not. I note, by the way, that *epoch* is also frequently used to denote a more or less vaguely specified interval of time, as in *glacial epoch*, but we are not concerned here with that usage.

If the ratio of two different units of time—that is, the frequency—varies from epoch to epoch, one measure of time is said to be *accelerated* with respect to the other. Such accelerations are the rule rather than the exception. Also, as a general rule, one clock is not only accelerated with respect to another, but the acceleration itself changes from epoch to epoch. Most of the work involved in practical determinations of time and frequency aims at determining the accelerations of clocks and changes in frequencies.

The foregoing definitions may be clarified by noting the analogies with the familiar terms used in connection with lengths. The correspondence is shown in two parallel columns in Table 1.

If we imagine a *scale of time* to be an indefinite sequence of units of time, in one-to-one correspondence with the real numbers, then an epoch is a specified instant in the time scale just as a position is a specified point in a length scale.

If two different units of time are denoted t_1 and t_2, then frequency is given by t_1/t_2, just as velocity is given by L/t_2, say.

Similarly a change of frequency, or an acceleration of t_1 with respect to t_2, may be expressed as t_1/t_2^2, just as ordinary accelerations are expressed as L/t_2^2.

It is worth noting that the reciprocal of a frequency is also a frequency, which is not the case with velocity. Also, the ratio of two frequencies is also a frequency, provided that one unit of time is common to both; for example, the ratio of t_1/t_2 to t_3/t_2 is t_1/t_3, while the ratio of two velocities is a pure number without dimensions, provided that the same unit of time appears in both. Thus the analogy between frequency and velocity is not complete.

It is important to remember that a change of frequency is itself an acceleration of one time scale with respect to another, and it cannot properly be called an acceleration of frequency. An *acceleration of frequency*, if the term is to be used at all, is a *change* in actual acceleration, of the form t_1/t_2^3.

Table 1. Correspondence of terms used in connection with time and length.

Time	Length
Epoch (specified instant, time of day)	Position (specified point)
Frequency, rate of a clock	Velocity
Change of frequency, acceleration	Acceleration
Change in acceleration	Change in acceleration

All that has so far been said about measures of time pertains equally to any measure of time whatever. In practice, it is obvious that some measures are preferable to others. We should not think of basing our fundamental unit of time on the passage of railway trains; in practice, we do the reverse, running our trains more or less to time instead of running our time to trains. Let us ask ourselves what we require of a measure of time in order for it to be suitable as a standard. Obviously we require it to be continuous. Also we require it to be easily accessible; of two measures that are equally good intrinsically, we prefer the one that is more readily accessible. But there is another essential requirement that is not so easily stated. We commonly express it by saying that a standard measure of time should be invariable, but in fact there is no absolute criterion of invariability. Suppose we compare two measures of time with each other and find one to be accelerated with respect to the other; we are able to conclude that one or both of the measures are variable, without knowing which one. If on the other hand no acceleration is observed, we are not able to conclude that both measures are invariable (within the errors of observation); in fact both may vary with respect to a third. Nevertheless, a precise meaning can be given to the invariability of a measure of time. To understand the matter fully it will be helpful for us to review a short chapter of the history of astronomy, which will explain how the second came recently to be redefined in terms of the tropical year instead of in terms of the mean solar day.

Celestial Motions

The equations of motion for any member of the solar system may be immediately derived from Newton's law of gravitation. (I do not speak of the refinements demanded by the general theory of relativity, which are not germane to the present discussion.) They take the form of three differential equations for each body, which express the second derivatives of the three coordinates with respect to the time as functions of the masses and mutual distances of all the bodies. The three equations for any body may be solved by successive approximation if we have sufficient information about the other bodies and if we know the six constants of integration, which may be taken to be the three rectangular coordinates and the three rectangular components of the velocity at any convenient epoch. The solution serves to give the three coordinates of the body as functions of the time reckoned forward and backward from the epoch, and the mathematical expressions are called a *theory* of the motion of the body. Since there are nine planets in the solar system massive enough to affect the motions of one another, it can readily be appreciated that the task of constructing a theory for any one of them is very considerable. Nevertheless, it has been accomplished with quite a high degree of precision. The coordinates of Jupiter, for example, have been calculated to ten significant figures for the years 1653 to 2060, so as to be strictly consistent with the initial conditions (*1*).

Astronomical Units of Mass, Time, and Distance

Let us examine the precise specification of the masses, the time scale, and the distances of our planetary theories. The unit of mass is the mass of the sun, all other masses being expressed in terms of it. The unit of time is commonly said to be the mean solar day, but as we shall see, this specification is not precise enough; the unit actually employed is the mean value of the mean solar day during the 18th and 19th centuries. The unit of distance is the astronomical unit, and it is derived from the units of mass and time by means of the Newtonian law of gravitation. For the present purpose, it will suffice to describe the unit of distance as the distance from the unit of mass at which a body of negligible mass, moving in a circular orbit, would move through an angle of 0.01720209895 radian precisely in a unit of time. The astronomical unit is nearly, but not quite, the same as the earth's mean distance from the sun.

To a physicist, the system of units of mass and length used by the astronomer must seem like a queer one. The reason for the choice of units is the peculiarly restricted nature of astronomical observations. With the exception of measurements of velocity in the line of sight, all that astronomers know about the motions, distances, and masses of celestial objects has been deduced from a single kind of direct measurement: the measurement of the angle between two lines

of sight from the observer. The result of an observation is a statement giving the value of an angle at an epoch. The angle is in some cases the angular distance between two celestial objects and in some cases the angular distance between one object and the plumb line. From such measurements alone, with the assistance of theory, the ratios of masses and the ratios of distances are deduced, but they cannot be expressed in grams or centimeters by any astronomical method whatever. It is true that we can state, to five or fewer significant figures, the masses of celestial objects in grams and their distances in centimeters, but to calculate them we must rely on physicists and geodesists to tell us the mass and size of the earth; such information is not needed for any astronomical purpose and astronomers never refer to it, except in answering questions put to them by non-astronomers.

Ever since the invention of mechanical clocks, astronomical observers have used the mean solar day as their unit of time. There are several reasons for this choice. In the first place, astronomers require a natural unit of time and not an arbitrary one. An arbitrary unit of time cannot be taken from place to place as easily as an arbitrary unit of length. Furthermore, all arbitrary units of time—that is to say, man-made ones such as those given by mechanical or electric clocks—are variable and evanescent; it has not been possible to build two mechanical or electric clocks that keep the same time or one clock that runs indefinitely without stopping. Hence a natural unit of time is a necessity in order that astronomical observations made at different places and at different epochs may be compared with one another. Of all natural units of time available to the astronomer, the period of rotation of the earth is the most accessible and can be observed with the highest precision. It is only necessary to observe the meridian passage of a star on two successive nights in order to have the period of rotation of the earth immediately. It is true that stars cannot be observed in foul weather, but man-made clocks are good enough to carry on with from one clear night to the next, and also to subdivide the period of the earth's rotation into 86,400 parts. It is interesting to notice, by the way, that the development of man-made clocks has had its greatest successes in a country that is noted for its inclement weather, England.

The mean solar day is not quite the same as the period of the earth's rotation, and not quite so accessible, the sun being less readily observed than the stars. But astronomers have been glad to make the very slight sacrifice required in order that the unit of time shall be suitable for the regulation of their daily lives. To pass from the period of the earth's rotation to the mean solar day in practice, it is only necessary to multiply by the number 1.0027378118868. This number, which is an actual frequency, is one of the most accurately determined constants in physical science, if not the most accurate; only the thirteenth decimal is in doubt. It is important to note that the mean solar day is defined in such a way as to make the number an absolute constant—that is, the mean solar day faithfully follows the rotation of the earth, and anything that disturbs one disturbs the other.

Observation and Theory

Throughout the course of history astronomers have sought to calculate theories of the motions of planets and satellites that would agree with actual observations. With each major contribution to fundamental theory has come renewed hope of complete success, but continual increases in the precision of observations have doomed all attempts to failure, at least until our own generation, and of course what will happen in the future is not known. After the formulation of the law of universal gravitation, it seemed that all practical problems of celestial mechanics had been reduced to arithmetic. Then the advance of Mercury's perihelion was discovered, which was not to be explained for another half century. Also, it is one thing to reduce a problem to arithmetic and quite another thing to solve it. The calculation of a planetary theory or a lunar theory is one of the most formidable tasks known to scientists, at least in cases where eight or more significant figures are required in the coordinates. It is not only a task of multiplying millions of numbers—which was formidable enough in itself until a very few years ago—but of proving the results correct, and even more difficult, of planning the work in such a way that it could be accomplished at all. It has taken a decade of hard work to produce our best planetary theories, and our best two lunar theories have each been the work of 25 years. The motion of the moon has been particularly troublesome; probably as much effort has been devoted to the moon as to all other celestial objects combined.

About 80 years ago it began to be suspected that the difficulty in getting theory and observations to agree might be ascribed, at least in part, to defects in the measure of time instead of to inadequacies of theory. In order to help us understand the consequences of a defect in the measure of time, let us imagine several things that are not the case. Suppose first that we have theories of the motions of all celestial bodies that agree with observations; suppose further that the rate of rotation of the earth is decreased imperceptibly, so that it is not detected by man-made clocks; and suppose that observations of the sun, moon, and planets are suspended until mean solar time has fallen an hour in arrears. What will be noticed when observations are resumed? Evidently the sun, moon, and planets will all be observed in advance of their calculated positions by the angles that they move through in 1 hour. The moon, for example, in an hour moves through an angle that varies from about 0.48 to 0.68 degree during a month, and the variations are very precisely known; it would be readily apparent that the moon was ahead of its course, and we might be inclined to suspect an error in the lunar theory until we observed the sun. The sun would be ahead of its calculated position by an amount varying through the year from 136 to 166 seconds of arc; the discrepancy and its variation would easily be detected. Furthermore, an eclipse of the moon would be observed precisely 1 hour in advance of the predicted time. The planet Mercury would be observed sometimes east and sometimes west of its predicted position, depending on whether its apparent motion was direct or retrograde, and the amount and variation of the discrepancy would indicate that at any epoch Mercury was in the position calculated for an epoch 1 hour later. Similar observations and conclusions would be made for the other planets. The inescapable conclusion would be that either our clocks were 1 hour slow or else that the moon and planets had accelerated in their orbits until they were an hour in advance, and had then returned to their normal velocities. In other words, either the measure of time was at fault, or else the theories of the motions of the moon and planets contained errors of a very curious sort.

Something like the hypothetical example just described has actually occurred, only it has not been a case of the clocks and the earth's rotation losing precisely an hour. In order to reconcile observations with theory, it is necessary to suppose that the clocks are sometimes fast and sometimes slow, the earth rotating at faster than its average rate for some years, and then changing rate rather quickly, so that it rotates more slowly, or even faster. Two thousand years ago, according to observations of solar eclipses made then, a clock keeping mean solar time would have been 2.6 hours slow. At about 1750 the clocks were on time; at 1850 they were 2 seconds slow; at 1900 they were 3.9 seconds fast; and at 1940 they were 24.5 seconds slow (*2*). The relatively large error at the beginning of the Christian era will not cause astonishment if it is remem-

bered that we have adjusted our measure of mean solar time to make it fit the average duration of the mean solar day during the 18th and 19th centuries; at very remote epochs the errors may be expected to be much larger than in our own time.

Astronomers have had no hesitation in ascribing the discrepancy to errors in the measure of time rather than to errors in the theories of motion. It is fair to ask why. Several answers are possible, according to the point of view taken. To those who believe in Occam's razor (economy of hypotheses) the answer is obvious; either we must suppose the earth's speed of rotation varies unpredictably or we must suppose that the moon and planets vary in their orbital motions, also unpredictably, but in concert, and that the astronomical unit of length varies accordingly, accompanied by variations in the velocity of light. To those who believe in general relativity, it is enough to point out this last consequence, for the constancy of the velocity of light is a fundamental postulate of general relativity. To those who accept a hypothesis only if it is accompanied by a suitable mechanism, it was not possible to say anything until a very few years ago; even now the mechanism that produces changes in the earth's rate of rotation is scarcely understood. It is thought, however, that turbulence in the liquid core of the earth, accompanied by electromagnetic coupling between the core and the mantle, is sufficient to account for the changes. Finally, to practical horologists who recall the days before radio time signals when ships carried three chronometers, and when confidence was placed in the two that agreed with each other in preference to the one that disagreed, it is only necessary to point out that the rotation of the earth and the revolutions of the moon and planets are in fact clocks. Four of them —the moon, Mercury, Venus, and the earth's revolution—agree, while the earth's rotation disagrees with all the others.

The outer planets are clocks just as the three inner ones are, and in fact all celestial bodies are clocks, but most of them have such slow angular motions in consequence of their great distances that the motions during a second or two cannot be measured with sufficient precision for checking the earth's rotation. Thus we see that there is still another requirement that a practical measure of time must fulfill; in addition to being continuous, accessible, and "invariable," the recurring phenomenon that is being counted must recur moderately often. The meaning of *moderately often* depends on the precision of astronomical observations. In the present state of astronomy, a year is the longest natural unit of time that is of practical value. If the precision of astronomical observations were, however, to increase tenfold, then the revolution of Jupiter, which is accomplished in about 12 years, would provide a measure of time sensibly as good as the revolution of the earth is at present.

Ephemeris Time

We are now in a position to understand why the second has recently been redefined as a definite fraction of the tropical year rather than as a definite fraction of the mean solar day (*3*). And we are in a position to understand in what sense a measure of time may be said to be invariable; an invariable measure of time is simply the measure that brings the theories of the motions of celestial bodies into agreement with observations. Stated even more concisely, it is the independent variable of the accepted equations of motion. There is, however, no practical necessity for speaking of an invariable measure of time at all, and we shall see later why it may be inadvisable to do so. The word *invariable* implies something absolute in the minds of most persons, and it may be better to avoid it when we are speaking as precisely as possible. All that is really necessary for practical and scientific purposes is to choose a measure of time that appears suitable and to define it precisely. For convenience, a special name has been given to the measure of time that is the independent variable of the equations of motion; it is called *ephemeris time* in contradistinction to mean solar time. An *ephemeris* is a table of the positions of a celestial body at various epochs, calculated according to the accepted theories of motion; ephemeris time, then, is merely the measure of time defined by an ephemeris.

In redefining the second, it was specified that the tropical year for 1900.0 should be used, the decimal indicating the beginning of the year 1900. The reason for the qualification is that the tropical year (which corresponds to the seasons) is decreasing at the rate of 0.530 ephemeris second per century, or 1 in 5.95×10^9 per year. The variation being known, it is easy to relate any particular year to the tropical year for 1900.0 with a precision of 1 in 10^{13}.

Ephemeris time is determined in practice by observations of the moon; the moon moves more rapidly than the planets, and hence the time can be determined from the moon with greater precision. A single observation of the moon does not, however, fix the ephemeris time with the required accuracy. Until very recently it has been necessary to observe the moon for a year in order to accumulate enough observational material to be of value. Some time is also required for working up the observational material; hence our determinations of ephemeris time are about 2 years in arrears. The recent development by Markowitz of a new photographic technique for observing the moon (*4*) has resulted in a considerable increase in precision; it now appears that in a very few years we shall be able to determine ephemeris time from month to month as accurately as we have done from year to year. Even at best, however, ephemeris time cannot be determined as accurately as mean solar time. The earth rotates about 27 times as fast as the moon revolves, which is a considerable advantage; an error of 0.1 second of arc in observing an equatorial star corresponds to an error of 0.007 second of mean solar time, while the same error in observing the moon corresponds to an error of 0.18 second of ephemeris time. Ephemeris time is less accessible than mean solar time. Thus, in redefining the second so as to derive it from the year instead of the day, we have substituted a less accessible invariable unit for a more accessible variable one.

Precision of Determinations of Time

The practical determination of mean solar time consists in noting the instant, according to some mechanical or electric clock, when a star crosses the local meridian. The actual mean solar time of the star's meridian passage is known in advance by means of an extended series of special observations and calculations that will not be discussed here. The discrepancy between the actual time of meridian passage and the clock time gives the error of the clock. The clocks used for the purpose need not be set to the correct time, but instead, a record may be kept of their errors, which are continuously changing. This record permits any other clock, after comparison with the clock whose error is known, to be set to the correct time, preparatory to controlling the emission of radio time signals. But the time signals are not absolutely correct because of the errors in the astronomical observations and because of the errors in extrapolating the errors of the clocks.

The most precise instruments for determining mean solar time are the photographic zenith tube (*5*) and the Danjon astrolabe (*6*). With the photographic zenith tubes of the U.S. Naval Observatory, it is the practice to observe about 15 stars on every clear night, and the probable error of the mean result of a night's work is about 3 milliseconds. By *probable error* is meant the quantity that exceeds half of the actual errors, and is ex-

Table 2. Rough estimates of the probable relative errors with which different intervals of mean solar time are determined.

Mean solar interval	Probable error
1 day or less	1 in 10^8
30 days	1 in 4×10^8
365 days	1 in 10^{10}

ceeded by half of them. The best quartz-crystal clocks run with a precision greater than this, and they are used to smooth out the random errors in the astronomical observations from night to night, so that at a single observatory possessing the best instruments and clocks, the mean solar time can be determined with a probable error of, say, 2 milliseconds. The International Time Bureau at Paris, which is sponsored by the International Astronomical Union, intercompares the data supplied by the various national time services and thus is able to make, a year or so in arrears, still further improvements in the knowledge of mean solar time, the error at this stage being probably less than 1 millisecond. But for the present discussion, I shall assume a probable error of 2 milliseconds.

What has been said thus far relates to the establishment of the epoch; physicists and engineers in general are more interested in the establishment of frequencies or time intervals. For this purpose, the quartz clocks are more accurate than the astronomical observations over intervals of at least a few weeks, while for longer intervals the astronomical observations are more accurate than the clocks. So far as astronomical observations alone are concerned, any interval of mean solar time may be determined with an absolute error that has a probable value of 3 milliseconds, which is found by multiplying the probable error of a determination of the epoch by the square root of 2. The relative error of a determined time interval follows quite a different law. If observations were restricted to the two ends of the interval, the relative error would vary inversely as the duration of the interval, but if the interval is long enough so that many observations can be obtained within it, the accuracy is further improved, and is nearly proportional to the 3/2 power of the duration. Table 2 shows some rough estimates of the probable relative errors with which different intervals of mean solar time are determined by combining the indications of the best quartz clocks with the best astronomical observations.

The high accuracy indicated for an interval of 365 days is, however, of no practical value because the length of the day varies in an unpredictable manner every few years by as much as 1 in 10^8 or even more. For example, if the length of the day in 1936 is taken as the standard, then in 1923 it was longer by 1 in 10^8 and decreasing at the rate of 2 in 10^9 per year, while in 1940 it was also longer by 1 in 10^8, but increasing at the rate of 2 in 10^9 per year. The practical question is on the precision with which the newly defined second, or equivalently the length of the year, can be determined by observation. As has already been mentioned, the precision is less than it was for the old second, chiefly because of the relatively slow motion of the moon. In the past it has been necessary to collect observations of the moon for an entire year in order to determine ephemeris time with a probable error of about 100 milliseconds. This precision has been attained only in recent years; it corresponds to a probable error of 140 milliseconds in measuring the length of a single year, or 1 in 2×10^8.

Two very recent advances at the U.S. Naval Observatory have resulted in a considerable increase in precision. One is a precise survey of the marginal zone of the moon by Watts, which makes it practicable to allow satisfactorily for the irregularities of the surface; it must be understood that observations of the moon are referred to the bright edge of the visible disk, and any mountains at the points where measurements are made contribute to the uncertainty in ephemeris time. The other advance is the new observational technique already referred to, which relates the moon to several stars in the immediate neighborhood, while eliminating the errors of measurement caused by the moon's motion among the stars. It is now possible with a single telescope to determine the length of the year with a probable error of 1 in 4×10^8. Only one telescope is now working, but it is planned to put twenty in operation during the International Geophysical Year, 1957–58, so it may be expected that the length of that particular year will be determined with a probable error of 1 in 2×10^9. It is reasonable to suppose that at least four telescopes will continue to work indefinitely. Assuming that number, then the probable relative errors of determinations of ephemeris time intervals are those shown in Table 3.

The probable error for 1/12 year or less is based on the assumption that quartz-crystal clocks are used to subdivide the year; the astronomical observations are not so precise for short intervals. It must be understood that determinations having this precision are possible only in arrears, the delay being perhaps a year. Although the delay does not detract from the permanent value, it is a drawback in the short term.

Table 3. Probable relative errors of determinations of ephemeris time intervals.

Ephemeris time interval	Probable error
1/12 year or less	1 in 10^9
1 year	1 in 10^9
5 years	1 in 10^{10}

Atomic Standards

During the past few years, techniques have been devised that make it possible to obtain access to the natural vibrations of atoms and molecules. There is no reason to doubt that such vibrations have a very high degree of reliability, equal to the revolution of the planets around the sun and the moon around the earth. The practical difficulty lies in counting the number of them occurring in a second, which is of the order of 10^{10}. Several techniques have recently been devised for the purpose, and the natural resonant frequency of the cesium atom has been measured with a stated precision of 1 in 10^9 by Essen and Parry at the National Physical Laboratory in England (*7*). Essen and Parry state that the potential precision is considerably higher, but special electronic techniques will have to be developed before the higher precision can be utilized.

Thus there has become available a new standard of frequency, which can be used for the calibration of another frequency with the same precision being attained in a few minutes as can be obtained from astronomical observations in a year. This important advantage indicates that for some purposes atomic standards of frequency will soon be used in preference to astronomical ones. The atomic standard does, in fact, supply us with a natural unit of time independent of the second, and of quite a different character, being independent of the motions of celestial bodies, at least in an operational sense.

A very important question for basic science is whether atomic frequencies, stated in terms of the astronomical (ephemeris) second, are constant or variable. Physics provides us with no certain answer to the question, which will have to be settled by experiment. E. A. Milne and his collaborators constructed an elaborate physical theory called kinematic relativity (*8*), in which two natural time scales appear, one being continuously accelerated with respect to the other, so that the ratio of the two units of time is continuously increasing; the change at the present epoch is supposed to be a little less than 1 in 10^9 per year. Dirac, Milne, Jordan, and others have suggested that one of these units may be identified with atomic frequencies and the other with astronomical ones. If that is in fact the case, then it should be possible to measure the acceleration in about 5 years,

and our earlier notions about invariable units of time will have to be drastically revised. We shall have no reason to favor one unit over the other by calling it invariable, and the word will no doubt drop out of use. Obviously, if such an acceleration is observed, the effect on basic physical theories and on cosmogony will be great and far reaching.

Atomic Unit of Time

Before atomic standards of frequency can be used in preference to astronomical ones, it is necessary to determine the frequency of the atomic standard itself in terms of the second. As noted before, this has already been done in terms of the old mean solar second, but it is desirable to do it also in terms of the new ephemeris second, which will require some time. Once it is done, then in all probability the astronomical second will soon be forgotten by most persons who work with the atomic standard from day to day, and there will be danger of confusion, particularly if the atomic and astronomical units should not have a variable ratio, or if the variation should be so small that a long time is required for its detection. Similar confusion does already exist to some extent with units of length.

The meter is defined as the distance between two marks on a certain bar of platinum. But some physicists have found it more convenient, instead of actually using the meter as a unit of length, to use instead the wavelength of a specified spectral line of cadmium or mercury; in many cases, wavelengths can be compared with one another with greater precision than that with which a wavelength can be compared with the meter. The number of standard wavelengths in a meter has been measured to a certain precision, and that is sufficient for the time being. But the number of wavelengths in a meter is an experimentally determined quantity, subject to revision and improvement. What is to be done each time a revision is made? Shall we attempt to revise every measurement in which wavelengths have been employed? Evidently such a procedure would be entirely impracticable. In order to prevent confusion from occurring, it is only necessary to adopt a new standard of length, say the angstrom, which is no longer to be regarded as precisely 10^{-10} meter, but is defined to have a fixed and invariable relation to the standard wavelength, the number of angstroms in a meter being experimentally determined and subject to revision. Thus, when measurements of lengths are stated in angstroms, it is to be understood that they are referred to atomic wavelengths, and when they are stated in meters, to the standard meter.

It is very desirable to treat the units of time similarly. We should reserve the word *second* to mean the astronomical second, and adopt a new unit, which I shall here call the *essen*, and which would have a fixed and invariable relation to the frequency of the cesium atom, being very nearly a small aliquot part of a second, the exact number of essens in a second being subject to experimental determination and revision. Then any frequency stated in cycles per essen would be understood to be referred to the atomic standard, while frequencies stated in cycles per second would be understood to be referred to the astronomical second. The distinction between the atomic unit of time and the astronomical unit of time is all the more necessary because both will remain in use for an indefinitely long time.

Consequences of Adopting an Atomic Unit of Time

Two important consequences would result from the adoption of an atomic unit of time that is to be used concurrently with the astronomical second. The first arises from the fact that the atomic unit of time is not independent of the atomic unit of length in the sense in which the meter is independent of the second. Wavelengths and frequencies are connected by a definite physical relationship: the product of the two is the velocity of light. Thus, if the velocity of light were known with sufficient precision, a wavelength could be deduced from a frequency, and vice versa. In fact, the velocity of light (in terms of the astronomical second) is uncertain by a part in 10^6 (recent determinations that have stated probable errors of 1 in 3×10^5 should not be taken at their face value until the discrepancy with earlier determinations is explained), and so this procedure cannot be used. But it would appear that the frequency of the cesium atom (in terms of the astronomical second) might be combined with the wavelength (in terms of the meter) so as to obtain an improved value for the velocity of light.

In discussing this matter, the greatest care is necessary in order to avoid circular reasoning. Let us assume that an atomic unit of time has been adopted, together with the atomic unit of length, and let us ask ourselves, In what sense, if any, is the product of a wavelength and a frequency, expressed in these units, to be regarded as the velocity of light. The answer is that such a product of numbers is not the value of the velocity of light, and in fact has no physical significance whatever; it is merely a number that was determined in advance when the atomic units of time and length were adopted. Thus, to say that the velocity of light is so many meters per second is to express an experimental result, but to say that the velocity of light is so many angstroms per essen (using the words in the sense I have suggested) is a tautology.

It is well known that the constancy of the velocity of light is a fundamental postulate of general relativity. What, then, becomes of general relativity if atomic time should turn out to be accelerated with respect to astronomical time? No doubt we shall hear it said that general relativity has been refuted, but that will not necessarily be the case. There are three valid ways of expressing the velocity of light: in meters per second, in meters per essen, and in angstroms per second; all three are the expressions of experimental results. The questions will be: (i) In which of the three modes of expression is the velocity of light variable? and (ii) Which of the three is referred to in the postulate of general relativity?

The second consequence of the adoption of an atomic unit of time arises from the fact that the atom, while being a natural standard of frequency, and in this respect much superior to arbitrary standards such as quartz crystals, which have to be continually compared with a natural standard, cannot be made to control a natural clock. In other words, there is no property of atomic vibrations that can be used to establish an epoch, as is done by the passage of a star over the meridian of Greenwich. It is true that atomic clocks can be built and that they will be very useful as secondary standards of time, but it will not be possible to adopt them as fundamental standards. They will not run indefinitely, but will stop occasionally because of failures in electric power of one sort or another. When they are started again, it will not be possible to ascertain the amount of time lost except by comparing them with other clocks that have continued running in the meantime. The only way of comparing clocks at some distance from one another is by means of radio time signals, which have variable velocities of transmission. Thus, after the adoption of an atomic standard of frequency, two units of time will be in use, one for frequencies and the other for measuring time itself.

Measure of Performance Q

There is a quantity Q that I venture to mention here only because it has occasionally been used (and more often misused) as a measure of the excellence of clocks. Among the more important legitimate applications of Q is the measure of the performance of resonant electronic circuits. In this application, Q is a measure of the sharpness of tuning—the sharper the tuning the higher the Q. Here

Q is equal to the ratio of the resonant frequency to the bandwidth between the frequencies on opposite sides of resonance where the response of the circuit differs by 3 decibels from that at resonance. Quartz-crystal clocks employ an electronic circuit that is tuned to the frequency of the crystal. Evidently, the higher the Q of such a clock, the more accurately the clock will count the vibrations of the crystal. With the techniques employed for atomic standards, the variation of response with frequency is similar to that of a resonant circuit, and so it has been found convenient to define the ratio of the frequency of maximum response to the 3-decibel bandwidth as an equivalent Q, which effectively measures one characteristic of such a standard.

Now there is another quantity δ, which is the symbol for logarithmic decrement, that is of importance in connection with damped oscillations such as spark discharges. It measures the amount of damping and is equal to the natural logarithm of the ratio of the amplitudes of two consecutive oscillations. It turns out that for a transient discharge through a resonant circuit, $Q = \pi/\delta$, π being the familiar constant 3.14159. This relation makes it possible to measure the damping by Q as well as by δ, a large Q corresponding to a small δ.

Having applied Q to damped electric oscillations as a measure of the damping, it was only a step to apply it by analogy to measure the damping of any damped oscillation whatever, such as the vibrations of a tuning fork or of a pendulum. It has been asserted, as proof of the superiority of atomic standards over pendulum clocks and quartz clocks, that the latter have a Q of only 10^6, while the Q of the former is much larger, various figures between 10^7 and 10^{18} being cited. Of these figures, 10^{18} is the Q approached in molecular transitions, while 10^7 is a value that may reasonably be expected to be attained in practical applications. These entirely misleading comparisons produced considerable confusion because the fact is that Q has about as much to do with the performance of a clock as the size of the battery has to do with the performance of an automobile; a certain size for either is a necessary, but not a sufficient, condition.

There are two principal reasons why Q is not useful as a measure of the performance of clocks. The first is that in clocks the natural damping of the pendulum or quartz crystal is counteracted by applying power in such a way as to maintain the oscillations at a nearly constant amplitude. Thus Q has a meaningful value only during the interval between successive applications of power, which may be made as often as we please. The way in which the power is applied is the most important single factor in determining the performance of a pendulum clock. The second reason is that the amplitude of the oscillations has nothing to do with the precision of a clock, provided that the changes in amplitude do not affect the frequency, or that they do affect it in a determinate manner. The clock that is provided by the rotation of the earth, for example, is supposed to be retarded by tidal friction, the corresponding value of Q being about 10^{13}, and the frequency changing by 1 in 5.3×10^9 per year. This retardation, provided that it is known and allowed for, does not detract from the excellence of the clock in the slightest degree. It is rather the irregular unpredictable changes of frequency that have led to the redefinition of the second in terms of the tropical year.

All that can properly be said of Q in connection with standards of time and frequency, and of the size of batteries in automobiles, is that they should not be so small that they constitute an effective limitation on performance.

Carbon Clock

For completenesss, it may be desirable to mention an entirely different sort of measure of time from any discussed thus far: the measure that is furnished by the radioactive decay of isotopes of various elements. In recent years, an isotope of carbon has been extensively used for the purpose, the proportion of the isotope present at any time being a measure of the time elapsed since the carbon was deposited. The principal use of this measure of time has been for dating fossils and geologic deposits. It is worth noting that the carbon isotope is in fact a clock, according to the definition stated earlier. The recurring phenomenon that is counted is the decay of an atom of the isotope. It is true that the decayed atoms can be counted only statistically and not individually, but this is not a drawback in principle, although it does severely limit the precision; if a technique could be developed for counting the individual transformations as they occur, the clock might become quite precise. The carbon is also a natural clock; the epoch it establishes is the epoch at which the carbon was deposited. It is not, however, suitable as a fundamental standard because it is not unique; there are as many different epochs as there are deposits.

Requirements for a Standard of Time

We may now reformulate the requirements for a satisfactory standard of time. We have seen that in fact there is no requirement for the invariability that was mentioned earlier because there is no way of determining whether a measure of time is invariable or not. For invariability we may substitute the requirement that, of two satisfactory standards, the acceleration of one on the other must be constant (or zero). Thus, a satisfactory standard of time must be continuous, must be accessible, must have a constant acceleration on other satisfactory measures, must be based on a unit that is neither too long nor too short, and must establish a unique epoch. Of two satisfactory standards of time having a mutual acceleration, the one to be regarded as fundamental is the one that leads to no contradiction between observations and physical theories. If it should turn out, for example, that the measure of atomic time is consistent with quantum mechanics while the measure of astronomical time is consistent with general relativity, one being accelerated on the other, then it will be the worse for at least one of the theories; it will be necessary to remove the contradiction in the theories before it can be decided which of the two measures, if either, is the fundamental one.

The requirements for a satisfactory standard of frequency and for a fundamental standard are the same as those for a standard of time, except that a standard of frequency need not establish a unique epoch. The requirement for continuity may also be somewhat relaxed; a standard of frequency need be continuous only over any time interval that it is required to measure.

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Nothing has tended more to retard the advancement of science than the disposition in vulgar minds to vilify what they cannot comprehend.—SAMUEL JOHNSON.

Fractionation of Oxygen Isotopes during Respiration

George A. Lane and Malcolm Dole

The stable isotopes of oxygen have been separated by a number of physical processes such as thermal diffusion and distillation. In addition to the physical methods of separation, the oxygen isotopes (*1*) are known to fractionate in the following types of chemical reactions: (i) equilibrium isotopic exchange reactions such as those between carbonate ions and water or carbon dioxide gas and water, (ii) decomposition reactions such as the decomposition of hydrogen peroxide (*2*) or the decomposition of ammonium nitrate (*3*), and (iii) oxidation reactions such as the formation of oxide films on metals (*4*).

Isotopic fractionation of oxygen in living systems was investigated for the photosynthesis reaction by Dole and Jenks (*5*), who found that the liberated oxygen had the isotopic composition calculated for isotopic exchange equilibrium between oxygen and liquid water. Because the equilibrium constant for this reaction, as calculated by Urey (*6*), is very close to unity, photosynthetic oxygen has an isotopic composition close to that of the oxygen in water with definitely less O^{18}, speaking relatively, than the oxygen already present in the atmosphere (*1*). Dole, Hawkings, and Barker (*7*) found only a very small fractionation factor, about 1.003, for the consumption of oxygen in bacterial respiration, but Rakestraw, Rudd, and Dole (*8*) discovered that sea life consumed the O^{16} isotope in the oxygen of air dissolved in the ocean at a slightly more rapid rate than the O^{18} isotope, the fractionation factor being 1.009 (*9*).

Barker (*10*) and Rabinowitch (*11*) suggested independently that the cause of the Dole effect (*12*), which is the greater ratio of O^{18}/O^{16} in atmospheric oxygen than in the oxygen of water, might be the result of fractionation during the back thermal reaction in the oxygen cycle, or in other words in the respiration of oxygen. Barker (*7*) thought that the bacteria living in the soil would be mainly responsible.

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To calculate the fractionation factor for the relatively greater consumption of O^{16} as compared with O^{18} by respiration required to substantiate the back thermal reaction theory of the Dole effect, it is necessary to know the average O^{18} content of photosynthetic oxygen, fresh water, and ocean water and to make an estimate of the relative contribution of photosynthesis from fresh and ocean waters. From the estimates given by Rabinowitch (*11*, p. 7), we have assumed that 85 percent of photosynthesis occurs in the oceans and 15 percent in fresh water. Using the percentage of O^{18} values given in Table 1, we can calculate that photosynthetic oxygen contains on the average 0.2003 percent of O^{18}. The ratio of the percentage of O^{18} in atmospheric oxygen to that in photosynthetic oxygen, 0.2039/0.2003, gives what we might call the oxygen isotope 16 production factor, or 1.018. For a steady-state condition, this must also equal the fractionation factor during respiration. It was the purpose of the research described here to study oxygen isotope fractionation factors during the respiration of typical biological systems and to test the back thermal reaction theory of the Dole effect. We felt that the earlier work of Dole, Hawkings, and Barker (*7*) needed to be repeated, using different biological systems and more accurate isotope abundance measuring equipment.

Plan of the Experiment

Using an apparatus similar to that described by Brown (*13*), we allowed various organisms to grow in air with the carbon dioxide removed by absorption in KOH solution and with the respired oxygen being continually replaced by pure oxygen from a Saran balloon. After a length of time, the oxygen of the air in the flask containing the organism was analyzed for its percentage of oxygen and for the percentage of O^{18} in the oxygen. The mass spectrometer used for these measurements has already been described (*9*).

Let a fractionation factor α be defined as the ratio of the percentage of O^{18} in the oxygen of the air in contact with the organism to the percentage of O^{18} in the oxygen being consumed by the organism at any moment:

$$\alpha = y/y_r \qquad (1)$$

where y is the percentage of O^{18} in the air of the flask at any selected time and y_r is the percentage of O^{18} in the oxygen being consumed by respiration at that same selected moment. This definition of α makes α greater than unity if O^{16} is consumed at a relatively more rapid rate than O^{18}. The differential material balance equation for the O^{18} isotope on respiration of dn moles of oxygen then becomes

$$n_0(y + dy) = n_0 y - y_r dn + x_0 dn \qquad (2)$$

where n_0 is the initial number of moles of oxygen in the respiration chamber (should be constant throughout the experiment) and x_0 is the percentage of O^{18} in the oxygen entering the respiration chamber from the Saran balloon. Eliminating y_r by means of Eq. 1 and integrating, we obtain

$$\alpha = \frac{y - y_0 e^{-m/\alpha}}{x_0 - x_0 e^{-m/\alpha}} \qquad (3)$$

where m equals n/n_0, the ratio of oxygen consumed to the amount of oxygen initially in the respiration flask. Inasmuch as α is close to unity, α can be calculated from Eq. 3, first assuming α in the exponential terms to be equal to y/x_0. The calculation can then be repeated using the new value of α. Or, if the organism respires enough so that m is 3 or 4, the exponential terms become insignificant and α is then equal to y/x_0. If an excess of pure oxygen leaks into the flask, the analysis of the air will indicate such an effect and a correction to the data can be readily applied.

A special apparatus was used for the *Homo sapiens* experiment in which the human being under observation breathed through one tube from a reservoir of air whose oxygen supply was continually replenished, and breathed out through another tube. His exhaled breath passed first through a large KOH tube, then through a sampling flask before it was rebreathed. Two rubber balloons at-

Table 1. Oxygen-18 content of oxygen from various sources.

Source	O^{18} (%)	Reference
Air	0.2039	(*16*)
Fresh water	0.1981	(*17, 18*)
Ocean water	0.1995	(*18*)
Photosynthetic oxygen from fresh water	0.1991	(*5*)
Photosynthetic oxygen from ocean water	0.2005	(*5*)
Average photosynthetic oxygen	0.2003	

tached to the KOH reservoir enabled the gas volume of the system to expand and contract with each breathing cycle and permitted quick estimates to be made of the amount of additional oxygen required.

Results and Conclusions

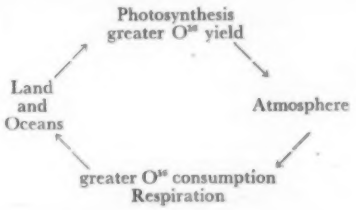
Figure 1 illustrates the data that are also collected in Table 2, where the order of agreement between successive experiments can be seen. The dotted vertical line of Fig. 1 represents the fractionation factor required to account quantitatively for the Dole effect. If we assume that the consumption of oxygen is entirely by respiration with allocation to various organisms according to the schedule, 75 percent to bacteria, 10 percent to other fungi (5 percent to molds and 5 percent to mushrooms), and 15 percent to higher plants (leaves and roots), a composite α equal to 1.016 is calculated. This division of the respired oxygen among the various species has no quantitative basis; however, if the allocation is changed to 50 percent bacteria, 10 percent molds, 10 percent mushrooms, 15 percent leaves, and 15 percent vegetables, the composite α is scarcely changed; it is 1.017. The forest litter experiments were performed on material (leaves, sod, and so forth) that was collected during October when biological activity was declining; nevertheless, the fractionation factors obtained were close to the average values estimated. Within the limit of uncertainties of the calculations and of the experimental results, the composite fractionation factors are in good agreement with the value of α equal to 1.018 that is required to explain the Dole effect.

It is interesting to note that α for the fiddler crab, 1.010_5, a marine animal, agrees well with the value 1.009 found for α by Dole, Lane, Rudd, and Zaukelies (*9*) in the consumption of oxygen by marine organisms living in the ocean.

There was a considerable fluctuation in the results for the bacterial experiments for reasons unknown to us.

Oxygen Isotope Cycle

Similar to an oxygen cycle in nature, we can now write down an oxygen isotope cycle as follows:



Photosynthesis yields oxygen containing a higher O^{16}/O^{18} ratio than the oxygen of the atmosphere, while respiration consumes oxygen containing a higher O^{16}/O^{18} ratio than the oxygen of the atmosphere and the same ratio as that of photosynthetic oxygen, thus leading to the nonequilibrium steady-state value of the O^{16}/O^{18} ratio in the atmosphere. In other words, the O^{16}/O^{18} ratio of atmospheric oxygen has risen to a point such that the ratios for photosynthetic oxygen delivered to the atmosphere and the oxygen extracted from the atmosphere by respiration are equal (*14, 15*).

Table 2. Oxygen isotope fractionation factors during respiration. The average fractionation factor for all vegetables was 1.009; for all bacteria 1.015.

Organism	Fractionation factor	
	Expt.	Av.
Homo sapiens	1.015	1.018
	1.019	
	1.019	
Spinach leaves	1.029	1.025
	1.024	
	1.023	
Crab (*Uca pugilator*)	1.011	1.010_5
	1.011	
	1.009	
	1.011	
Frog (*Acris crepitans*)	1.006	1.007
	1.009	
Carrot	1.010	
	1.008	
Potato	1.009	
Mushrooms (*Agaricus campestris*)	1.025	1.023
	1.023	
	1.022	
Molds (*Penicillium*)	1.019	1.018
	1.018	
	1.017	
Bacteria (*Aerobacter aerogenes*)	1.012	
	1.029	
Bacteria (*Achromobacter fischeri*)	1.008	
	1.013	
	1.017	
	1.021	
	1.008	
Forest litter (upland oak and hickory forest)	1.014	
Forest litter (subclimax oak and maple floodplain forest)	1.016	

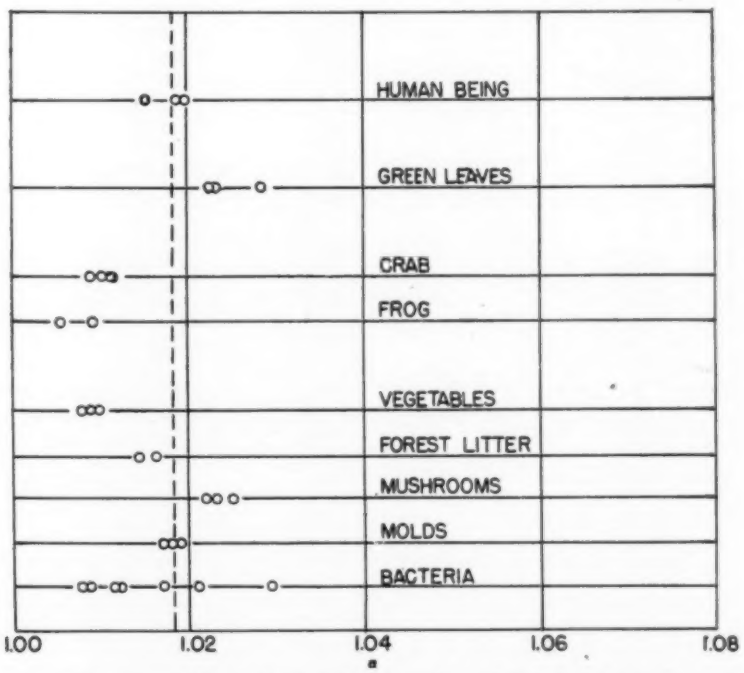


Fig. 1. Oxygen isotope fractionation factors for various biological systems.

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R. C. Osburn, Connoisseur of Living

When I first met Raymond C. Osburn in 1936, he was 64 years old and chairman of the department of zoology and entomology at Ohio State University. I came to him as a new member of the staff on the entomological side of his department. A tall, slim gentleman with the lines of his face emphasizing his happy nature, he received me graciously in his office. Looking at me through his horn-rimmed glasses with a lighted stogie in his hand, he talked easily about the department and his own interests. He was thoroughly at home in this book-filled, specimen-cluttered room, which contained a work table, a roll-top desk, and a highboy desk, at which he sometimes stood to do his work.

Osburn had worked in that room since 1917 and in the opinion of some members of his staff had become too comfortable there to exert himself competitively for the benefit of his department. I believe, however, that he was too gentle and honest and too absorbed in his professional work to apply pressure or to indulge in campus politics to obtain what was needed. He tacitly encouraged the senior members of his staff to help themselves, if they could; and they did. He was not without accomplishment, however, in the expansion of facilities for zoological research and teaching at O.S.U., for it was generally acknowledged that he was responsible for the establishment of the Franz Theodore Stone Laboratory at Put-in-Bay, Ohio, through the generosity of Julius F. Stone.

The only instrument I remember in Osburn's office was a binocular dissecting microscope, for he was essentially a direct observer of nature and a natural philosopher who did not resort to experimentation and instrumentation—an old-fashioned naturalist.

Osburn's broad professional interests are indicated by his membership in 22 societies, national and local; by the places in which he chose to spend his summers, usually hydrobiological stations; and by his numerous publications of amazing variety. He worked on Bryozoa, oysters, fish, dragonflies, and two-winged flies, particularly the beneficial flies of the family Syrphidae. He promoted the care and use of natural resources in Ohio, gave generous service to *Biological Abstracts,* and held office in many of his societies. Although no scientific law or well-known hypothesis is associated with his name, he added to zoological knowledge all along the line, and his advice and help were in demand in the aquatic side of his work.

Surprisingly, Osburn's most comprehensive and important work was done after his retirement at age 70 in 1942. Then he was called to Southern California to study the collections of Bryozoa made by the Hancock Foundation expeditions in Pacific waters from Alaska to Peru. He described and directed the illustration of many new species and produced three volumes on the taxonomy and distribution of these marine organisms. No one was more surprised than Osburn when, in recognition of the excellence of his work as represented by the first volume, he was named to receive the Daniel Giraud Elliot medal of the National Academy of Sciences for 1950. I was present in the auditorium of the National Academy on the evening of 26 April 1954 when Alexander Wetmore presented Osburn to the audience, and the award was conferred upon him by Detlev W. Bronk. At 82 he stood as straight and responded as easily and gracefully as ever. Then he and Mrs. Osburn departed for a visit to one of their favorite regions, the Great Smokies. What an inspiration to young biologists was this grand climax to Osburn's scientific career! He died on 6 August 1955.

To me Osburn was more important as a connoisseur of living than as an impersonal scientist. He loved literature and was noted among his students and friends for his ability to read poetry aloud. I once requested him to read *Tam O'Shanter* at a Hallowe'en party—he knew it by heart and declaimed it with relish in his rolling bass voice. He was noted also for his skill in composing light verse for any occasion. It sparkled with his quips and always had the light touch without barbs.

Thanks to modern electronics, Osburn seemed to be with us on the morning of 29 November 1955 in Cincinnati when Ohio State University alumni of his department assembled at breakfast in his memory. A recent tape-recording of his recitation of some of his most humorous verse was heard, and in our imagination we saw again that tall, gallant figure, stogie alight, eyes twinkling, head mobile, performing as of old.

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Everyone who enjoys thinks that the principal thing to the tree is the fruit, but in point of fact the principal thing to it is the seed. Herein lies the difference between them that create and them that enjoy.—FRIEDRICH WILHELM NIETZSCHE, *Maxims.*

News of Science

Southern Hemisphere Observatory

Although that part of the sky south of declination – 20° (more than 110° from the north celestial pole) comprises only one-third of the total area of the celestial sphere, this region, nevertheless, is one of crucial importance to the astronomer. Within this region may be found the center of our galaxy, most of the inner spiral arms, most of the globular clusters including the three brightest, the great majority of the known cepheid variables, the richest section of the Milky Way, and our two nearest extragalactic neighbors, the Magellanic Clouds. These critical objects are either invisible or at too low an altitude for effective observations to be possible with the comparatively numerous and more powerful telescopes in the Northern Hemisphere. Astronomers have long been accustomed to seeing diagrams connected with Milky Way research in which data for a third of the galactic circle were nonexistent; it is this sort of thing that has been described as "flying with one wing."

Northern galaxies such as the great nebula in Andromeda, for example, have made it possible for California astronomers not only to formulate the observational criteria necessary to establish the distance scale to the outer regions of the observable universe but also to come up with such fertile suggestions as the existence of two stellar population groups. The Magellanic Clouds, however, are at a tenth the distance of the Andromeda nebula; therefore stars in the two Magellanic Clouds appear to be 100 times brighter than stars of comparable candlepower in the Andromeda nebula. The spectra of the brightest, supergiant Magellanic Cloud stars could be studied in great detail, and much fainter stars, similar to our sun, could be studied by direct photography, if only appropriate telescopic power were available in the Southern Hemisphere.

Basic observational data—so necessary to an understanding of the sidereal universe—lag in some fields or are nonexistent in others in the Southern Hemisphere. For example, the number of known radial velocities north of + 20° is 3 times as great as for the stars south of – 20°. Furthermore, there is no counterpart of the Lick 20-inch astrographic or the Palomar 48-inch Schmidt surveys in the Southern Hemisphere, although there is no question that southern surveys with similar instruments would yield a rich and profitable harvest. Both the 200-inch reflector and the 48-inch Schmidt at Palomar have been used to make decisive observations concerning the identity and nature of the newly discovered strongest radio sources. The new and somewhat spectacular science of radio astronomy not only does not make such telescopes obsolete; it asks questions that can be answered—if at all—only by the best and largest optical telescopes presently available only in the Northern Hemisphere.

The news from below the equator is good, however, and promises that this observational unbalance will be alleviated, in part at least, in the near future. A 74-inch reflector is going through its final testing at the Commonwealth Observatory, Canberra, Australia, and joins the 74-inch Radcliffe reflector at Pretoria, South Africa, as the largest telescope in operation in the Southern Hemisphere. The Union Observatory also has plans for a 74-inch reflector and has already moved some of its observing equipment from Johannesburg, where the industrial smoke, haze, and city lights have become an increasingly serious problem, to a new site on the high veld near Hartebeestpoort Dam 20 miles west of Pretoria.

The Royal Cape Observatory, located 3 miles from the center of Cape Town, is acquiring a 40-inch reflector in 3½ years, which will cost $210,000 and will be located away from the city. This will be the first new major piece of equipment in more than 50 years for this observatory, which was founded by the British Admiralty in the 1820's. The Royal Cape Observatory has had a long and active history in the field of stellar astrometry and in more recent years has pioneered in the increasingly important field of precision stellar photometry.

The Boyden station at Harvard Kopje near Bloemfontein, Orange Free State, has recently come under the joint control of six observatories—namely, Harvard Observatory; Armagh Observatory, North Ireland; Dunsink Observatory, Eire; Hamburg Observatory, West Germany; Stockholm Observatory, Sweden; and Uccle Observatory, Belgium. The two main telescopes at Harvard Kopje are the 60-inch Rockefeller reflector and the 32-inch E ker-Schmidt telescope. The site is undoubtedly a good one, free of city smoke and lights, with winter observing conditions especially fine.

Despite all this evidence of southern hemispheric activity, none of the aforementioned telescopes matches the power of the three California reflectors, the 200-inch Hale telescope at Palomar, the 120-inch at Lick, and the 100-inch Mount Wilson reflector. Provisional plans have been announced, however, for a Joint European Southern Observatory, which will include a 120-inch reflector, a 48-inch Schmidt telescope like that on Palomar, and possibly a meridian circle. Such an observatory would have three main functions: (i) to help fill in the extensive gaps in our basic observational data; (ii) to provide first-class observing facilities for experienced astronomers who live in poor climates and who lack proper equipment; (iii) to take fuller advantage of the most unusual observing opportunities provided by the southern third of the sky. The observatory would cost $4.5 million, and the following six countries have taken part in the preliminary discussions: Belgium, France, Great Britain, Holland, Sweden and West Germany. An expedition of four European astronomers is now in South Africa investigating sites on the high veld and in the Karroo. Extensive and lengthy site-testing is necessary for such a large telescope, which becomes ineffective at times of poor seeing. The telescope should be located far from a population center in an atmosphere both stable and transparent a large part of the time. A similar site-testing program, sponsored by the National Science Foundation, is now studying possible sites in the southwestern United States in connection with the proposed new National Astronomical Observatory.

JOHN B. IRWIN
Goethe Link Observatory,
Indiana University, Bloomington

Need for Patent Examiners

American industry is facing long delays in obtaining patent coverage for products and processes that are otherwise ready for the market, according to reports made at a recent meeting of the New York Patent Law Association, which was addressed by the Commissioner of Patents.

These delays stem from the great increase in the number of patent applications filed during the past few years. The flood of inventions has stretched

the average prosecution time per patent to 3½ years.

The association points out that the patent examiner thus holds a key position in the advancement of American technology and that the only way to reduce these delays and clear the way for marketing the new products and processes is to employ new patent examiners to pass on the backlog of applications that have piled up in almost every technical field.

Steps have already been taken in this direction, and approximately 100 new patent examiners have been added to the examining staff since last June. It is understood that the Patent Office wants 300 new patent examiners in 1956; 125 in the first quarter, 25 in the second quarter, and 75 in each of the last two quarters. There are immediate openings for engineers and scientists who can accept appointments in Washington now.

Patent examiners pass on applications for patents in a wide range of technical fields to determine whether they are novel and whether invention is involved. This calls for a study of the issued patents and the related scientific literature. The association points out that the technical graduates who apply will find the job both interesting and stimulating and one that keeps them in close touch with the latest technical developments. The job offers opportunities for rapid advancement within the Patent Office. Washington also offers unusual opportunities to carry on graduate studies at the same time.

Salaries for examiners start at $4345 a year, and it is possible to reach a salary of $7570 in 5½ years, with salaries in excess of $13,000 available. The Patent Office also offers vacations and sick leave and pension benefits.

Engineers and scientists who hold a college degree in engineering or applied science, or a degree with a major in chemistry or physics, or with certain combined credits in these fields, are eligible for appointment as patent examiners, without examination, upon application to the Commissioner of Patents in Washington, D.C.

HENRY E. SHARPE
New York Patent Law Association

General Principles of Cooperation on Biological Abstracting

At their annual meeting on 18 Feb. 1956, the trustees of *Biological Abstracts* formulated and adopted the following general principles to guide their future course in matters of cooperation on biological abstracting.

Recent studies of the literature of biology and its coverage by abstracting services make it very evident that there is an urgent need for a wider and more efficient coverage of the world's biological literature. In an effort to provide biologists with a truly comprehensive abstract coverage of biology, the trustees of *Biological Abstracts* have adopted the following general principles of cooperation on biological abstracting as the basis on which they are prepared to cooperate with any and all abstracting and indexing services.

1) *Introduction*: (i) There is great need for more efficient abstract coverage of world biological literature. (ii) Certain areas of the literature of biology are well covered, but others are relatively untouched. (iii) Conservation of the time and efforts of biologists makes it imperative to devise ways to avoid duplication in abstracting services. (iv) An abstract is considered to be a greatly condensed version of an original research paper.

2) *Parties to any agreement*: (i) Biological Abstracts, Inc., would welcome the opportunity to negotiate specific bilateral agreements with any abstracting service under the broad terms of this instrument. (ii) These principles are so phrased that any abstracting service or association of scientists may cooperate. (iii) Indexing services are also invited to cooperate.

3) *Clear indication of areas of core coverage by a cooperating service*: (i) A hard *core of journals* which a cooperating service proposes to *abstract* as completely as possible should be made known in advance. (ii) Duplication of the abstracting of *core journals* should be avoided by each service, when possible. (iii) Service in a given country should give first consideration to adequate coverage of the major journals of its own country. Ease of access, speed of getting journal to abstractor, page proof, and language are factors that determine journal coverage. (iv) Services with limited subject interests could also participate by indicating the journals they would cover completely.

4) *Selective abstracting*: (i) To provide broad coverage, a cooperating service may, in addition to its core coverage, *publish* abstracts selected with reference to subject matter as well as geographic and linguistic representation. (ii) Selective abstracting may be done by staff and/or voluntary abstractors. (iii) Selective abstracting may also be accomplished by use of abstracts prepared by other services and reprinted under bilateral agreements.

5) *Permission to use abstracts of other services*: (i) By mutual agreement one service may use the abstracts prepared and published by another service, provided that credit for the source is given with each abstract. (ii) Percentage or number of abstracts so used would be specified in the agreement in order to insure that each service would be a substantial producer of new abstracts. (iii) Initially the percentage of abstracts used under reprint privileges should be a relatively small portion of the abstracts prepared by a cooperating service in order to protect the small specialized service from unfair competition. (iv) Selective reprinting would permit a cooperating service to include or exclude abstracts according to its own standards.

6) *Promotion of wider international cooperation*: (i) Greater international cooperation should be sought through appropriate international organizations. (ii) Wide publicity should be given to the availability of cooperation under the foregoing terms. (iii) The ICSU (International Council of Scientific Unions) Abstracting Board, which is promoting successful international cooperation in physics abstracting and is beginning to expand its services to chemistry, should be encouraged by UNESCO (United Nations Educational, Scientific, and Cultural Organization) to include biology in its scope. (iv) Cooperation in the abstracting of biology in medicine should be stimulated through CIOMS (Council for International Organizations of Medical Sciences) and WHO (World Health Organization). (v) Similarly, in agriculture the services of FAO (Food and Agriculture Organization) should be solicited. (vi) As opportunities develop, negotiations looking toward further integration of comparable services will be explored.

News Briefs

■ D. B. Carlisle and C. G. Butler have reported [*Nature*, **177**, 276 (1956)] that the "queen substance" of honey bees that normally inhibits ovarian development in worker bees would also inhibit ovarian development when injected into prawns from which the eyestalks had been removed. In prawns the sinus glands of the eyestalks contain a hormone that inhibits ovarian development during a part of the year. When eyestalks are removed from prawns with regressed ovaries, the ovaries grow rapidly. Thus, the alcohol extract of a queen bee has the same inhibitory effect as the eyestalk hormone.

In a reciprocal experiment, sinus glands were dispersed in a Potter homogenizer in 67-percent sucrose syrup. This was added to a pollen-candy mixture and fed to newly emerged bees; the control group was fed a pollen-candy mixture without any sinus gland additive. There was a highly significant inhibition of ovarian growth in the experimental group of bees after 19 days of such feeding.

The substances appear to be "the same or related compounds, possibly steroids." They are both stable to heat and acids, less stable in alkali, and soluble in alcohol and acetone.—G. DuS.

■ A comprehensive 20-year study of the seed plants and ferns of the southeastern United States is under way at Harvard University under the direction of C. E. Wood, Jr., of the Arnold Arboretum and Reed C. Rollins, director of the Gray Herbarium. The massive project, which will cover the plants of Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee, has the cooperation of botanists in several southern universities.

The project was first proposed and is supported by George R. Cooley, a retired Albany, New York, investment banker, who has devoted recent years to a study of the southern flora. The project also has financial support from the National Science Foundation. Present knowledge of the 1,000-mile-square area is based largely on a study made 35 years ago.

The new work will codify, illustrate, and describe the nature and geographical distribution of each plant group. Two volumes will treat ferns and seed plants that are not cultivated; a third volume will treat the cultivated plants. The plant names will be based on the International Code of Botanical Nomenclature.

■ A modified set of equations for his generalized theory of relativity, completed by Albert Einstein a few months before his death, has been published by the Princeton University Press as an appendix to the fifth edition of Einstein's book, *The Meaning of Relativity*. Much of Einstein's thought was a search for a unified and pure field theory—that is, a theory embracing the laws of electromagnetism and gravitation and excluding singularities. In the new edition Einstein wrote: "In my opinion, the theory presented here is the logically simplest relativistic field theory which is at all possible." However, he immediately adds, in effect, that whether the equations are more than a formal exercise is still an open question.

■ The Spanish government has ordered a 3000-kilowatt research reactor. The reactor, which is to be built by the General Electric Company, will use fuel enriched to 20-percent in uranium-235. The reactor is of the submerged or swimming pool type.

■ The Joint Committee on Atomic Energy has concluded a 2-day seminar in executive session on the problem of indemnification against reactor hazard. Representatives of the AEC joined atomic manufacturing, operating, and insurance interests in an exchange of views on the problems of providing adequate indemnification for reactor owners and manufacturers. Sen. Clinton P. Anderson (D., N.M.) stated that committee action with a view to solving any present problems would begin soon.

■ The National Park Service has found it necessary to reduce the northern elk herd in Yellowstone National Park by about 7000 head since December 1955. Of these, 6500 were killed by hunters and park rangers, and 650 were trapped and shipped to ranges in New Mexico and Montana. The population had reached 12,000, although the carrying capacity of the range is only about 5000.

Scientists in the News

WILLIAM R. HAWTHORNE, Jerome Clarke Hunsaker professor of aeronautical engineering at Massachusetts Institute of Technology, is giving this year's Minta Martin lecture in aeronautical centers throughout the country. The lecture series is supported by a special gift from the late Glenn L. Martin and, together with the professorship, is in honor of Hunsaker, a leading figure in aviation. The first lecture was given 21 Mar. at the University of Maryland under the auspices of M.I.T., the University of Maryland, and the Washington Section of the Institute of Aeronautical Science.

VIRGIL E. GOODWIN has been named manager of the Birmingham, Ala., branch of Central Scientific Company. Goodwin has had 9 years of experience in the industrial laboratory supply field.

ARTHUR H. COMPTON, physicist, formerly chancellor and now distinguished service professor of natural philosophy at Washington University, St. Louis, is giving a series of five lectures at Michigan State University on the following subjects: "Science and human goals," 5 Apr.; "Freedom and interdependence," 17 Apr.; "Economic potential and world population," 1 May; "Tensions and obsolescence of war," 15 May; and "How can freedom win?" 29 May.

G. PONTECORVO, professor of genetics in the University of Glasgow, has taken up residence as visiting professor of zoology in Columbia University for the spring term. During April he is delivering the Jesup lectures in the department of zoology. The general title of the lectures is "Present trends in genetic analysis." The first two lectures were given on 3 and 5 Apr. Others will follow on 10, 12, 24, and 26 Apr.

JAMES B. MACELWANE was recently given the Jackling award of the American Institute of Mining Engineers, posthumously. He was cited "For his outstanding work in geophysics, geophysical engineering, as a teacher; and for his lecture [the Jackling lecture, which he was preparing during his final illness], 'The earth sciences in the program of the International Geophysical Year, 1957–1958.'"

JAMES J. WARING of the Colorado Foundation for Research in Tuberculosis will give the first J. Burns Amberson lecture on 22 May, during the annual meetings of the National Tuberculosis Association and the American Trudeau Society in New York. The lecture is named in honor of Amberson, recently retired head of the chest service of Bellevue Hospital, New York, and professor of medicine, College of Physicians and Surgeons, Columbia University.

NIKOLAAS TINBERGEN of the University of Oxford is Walker-Ames professor of zoology for the spring term at the University of Washington, Seattle. He is presenting a series of lectures and conducting field observations on the behavior of some local animals.

WALTER B. SHELLEY, associate professor of dermatology at the University of Pennsylvania School of Medicine, gave the 1956 annual Sigmund Pollitzer lecture at New York University Postgraduate Medical School. He talked on "Recent studies on the physiology and biochemistry of itching."

C. D. W. THORNTON will head the activities in atomic energy of the Farnsworth Electronics Company of Fort Wayne, Ind., a division of International Telephone and Telegraph. Thornton comes from the Atomic Energy Commission at Washington, where he was director of the general manager's office of operations analysis and planning.

ROBERT F. INGER, curator of amphibians and reptiles at the Chicago Natural History Museum, will spend six months in the tropical rain forest of North Borneo, where he will collect and observe reptiles, amphibians, and fishes in an effort to achieve a better understanding of the rain forest environment. He will also establish a small weather station.

VERNON BRYSON has been appointed associate director and professor of the Institute of Microbiology, Rutgers University, effective 1 July. Bryson is program director of the Genetic and Developmental Biology Section of the National Science Foundation.

WILLAM A. McCLELLAN, general practitioner in Oxford, Ohio, for the past 7 years, has joined the staff of the University of Tennessee College of Medicine as assistant director of the department of general practice.

DAVID C. LEA has been appointed research and development manager of the Forest Products Division of Olin Mathieson Chemical Corporation, West Monroe, La. Lea formerly was with Potlatch Forests, Inc., Lewiston, Idaho, where he was technical director.

JOHN M. ERICKSON has been named associate professor of chemistry at South Dakota State College.

JEAN-PIERRE CORNAZ will spend a year with Stanford Research Institute's chemical engineering section, investigating new design techniques for ion-exchange columns. Cornaz formerly was scientific assistant with the Swiss Federal Institute of Technology at Zurich.

The Pittsburgh Section of the American Ceramic Society presented the ninth Albert Victor Bleininger award for meritorious achievement in ceramics to ARTHUR S. WATTS. Watts, professor emeritus, Ohio State University, was honored for his long years of service as a ceramic educator and his many contributions in the field of ceramics.

HERBERT H. KENT, who was formerly chief of the physical medicine and rehabilitation department of the Illinois Veterans Administration Hospital, has been appointed associate professor of physical medicine at the University of Oklahoma.

WARREN L. BAKER has been appointed chief of the technical industrial relations division, a new office of the Air Research and Development Headquarters that has been created to help secure scientific and technical contributions from organizations that have not previously held ARDC contracts. Baker was formerly with the Socony Vacuum Oil Company, where he headed the aviation division.

Recent Deaths

EDWARD A. COLMAN, Berkeley, Calif.; 45; director of the forest service watershed conservation studies in California; 20 Mar.

CLAIR E. FOLSOME, Plainfield, N.J.; 53; director and professor of obstetrics and gynecology at New York Medical College; former vice president and executive director of the Ortho Research Foundation; 19 Mar.

IRENE JOLIOT-CURIE, Paris, France; 58; professor of physics at the Sorbonne and director of France's radium laboratory; 1935 joint winner with her husband of the Nobel Prize in chemistry for the discovery of artificially induced radioactivity; 17 Mar.

GEORGE W. MULLINS, Woodstock, Vt.; 75; professor emeritus of mathematics at Barnard College; executive secretary of the College Entrance Examination Board from 1933–46 and one of the founders of Educational Testing Service; 11 Mar.

WILLIAM H. OVER, Vermillion, S.D.; 89; retired director of the museum of the University of South Dakota; 20 Feb.

GEORGE M. PRICE, Syracuse, N.Y.; 91; professor emeritus of surgery at Syracuse University; 20 Mar.

GEORGE SARTON, Cambridge, Mass.; 71; professor emeritus of the history of science, at Harvard University; founder of *Isis* and *Osiris*; author of numerous books and papers on the history and philosophy of science; vice president AAAS Section L in 1935; 22 Mar.

Education

■ A grant of $10,000 from the Fund for the Advancement of Education and the loan of equipment for a nominal fee by the Hi-Fidelity Center, Inc., Albany, N.Y., has made it possible for the Mount Pleasant High School in Schenectady to begin trying out instruction by use of closed-circuit television. The project will be expanded to provide for two studio classes and four served by television. The system permits students in the television classes to ask questions of the instructor. The first experiments were tried with advanced algebra and trigonometry classes; it is planned to extend the instruction to classes in science, French, and English. A maximum of 325 volunteer students will participate.

■ The Botanical Society of America will sponsor from 2 July to 11 Aug. a Summer Institute of Botany at Cornell University for 50 teachers from small colleges. The teachers will receive tuition, a stipend of $300, and, in some cases, allotments of $75 for each dependent.

The purpose of the institute is to give teachers the opportunity to learn of recent developments in their special fields of interest and to encourage them to start or continue research projects in their own departments. The institute is financed by a grant of $31,400 from the National Science Foundation. Harlan P. Banks, head of Cornell's Botany Department, will direct the staff of twelve botanists from twelve universities.

■ The National Science Foundation and the Atomic Energy Commission are sponsoring a new program in aid of science teaching in secondary schools. The program will be administered by the Oak Ridge Institute of Nuclear Studies, which is owned by 34 southern universities. Eight or ten high-school teachers will be selected to participate; they will spend 3 months in training at Oak Ridge and 9 months traveling to various high schools, at each of which they will spend a week giving lectures and demonstrations. Each will be provided with a station wagon and equipment for demonstrations in physics and chemistry.

Grants, Fellowships, and Awards

■ The John and Mary R. Markle Foundation has announced the appointment of 23 scholars in medical science, all faculty members of medical schools in the United States and Canada. The fund appropriated $690,000 toward the support of these doctors and their research, to be granted at the rate of $6000 annually for 5 years to the 23 medical schools where they will teach and carry on research.

The scholars were selected from 49 candidates nominated by deans of medical schools, each of whom presented a 5-year program for advancing the scholar in his academic career. The scholars and their fields are Alfred Jay Bollet, internal medicine; Clement E. Brooke, pediatrics; Nicholas P. Christy, internal medicine; Charles F. Crampton, biochemistry; Joseph Dancis, pediatrics; Vincent C. Diraimonda, internal medicine; Merlin D. DuVal, Jr., surgery; Frederic L. Eldridge, internal medicine; Henry A. Harbury, biochemistry; David T. Karzon, pediatrics and virology; Robert F. Kibler, internal medicine; David M. Kipnis, internal medicine; Ernest Knobil, physiology; Robert I. Merritt, obstetrics and gynecology; Ashton B. Morrison, pathology; Robert E. Parks, Jr., pharmacology; David M. Prescott, microscopic anatomy; Henry Z. Sable, biochemistry; Belding H. Scribner, internal medicine; Frank C. Spencer, surgery; Peter A. Stewart, physiology; Judson J. Van Wyk, pediatrics; W. Dean Warren, surgery.

■ The College Entrance Examination Board has invited social scientists who are interested in investigating the nonintellectual aspects of college success to submit short preliminary statements. Research plans should include: (i) a statement of the factors to be studied, the hypotheses involved, the criteria of college success to be employed, and the approximate study design to be followed, (ii) an estimate of the cost of preparing

a detailed research proposal in this area, (iii) an estimate of the total cost of the study that would be proposed, and (iv) a statement concerning the research personnel and facilities that would be available for such a study and the schedule that would be observed.

The board is seeking research that results in instruments that will predict college success, as measured by intellectual or nonintellectual criteria, or both, and which will be suitable for mass administration to high school students.

Address correspondence to Dr. Joshua A. Fishman, Research Associate, College Entrance Examination Board, 425 West 117th Street, New York 27.

■ The number of students who have received grants for foreign study under the Fulbright program has increased steadily, except in 1952–53, from 22 during the initial year, 1948–49, to 979 in 1954–55. There was a slight decrease in the year 1955–56 to 956. The total number of students who have participated in the program is 5549. Of these, the largest number studied in France (1681, or about 30 percent). The figures and approximate percentages for some of the other countries are United Kingdom, 1147 (21 percent); Italy, 750 (14 percent); Germany, 615 (11 percent); Austria, 236 (4 percent); Netherlands, 199 (4 percent); Norway, 149 (3 percent); Belgium and Luxembourg, 132 (2 percent); Australia, 117 (2 percent).

Germany did not receive any Fulbright students until 1953–54. In 1955–56 France still has the most Fulbright students (257), but Germany has moved into second place with 221.

Twenty grants were made for study in China in 1948–49, but only half of the grantees went there, owing to the change of government. None has gone to China since.

■ The Sapelo Marine Laboratory of the University of Georgia, which is supported by the R. J. Reynolds Foundation, has completed its second year of operation. Four full-time research men are in residence—Robert Ragotzkie, Larry Pomeroy, John Teal, and Richard Dugdale. These men, and G. H. Boyd, E. P. Odum, R. B. McGhee, D. C. Scott, and P. R. Burkholder of the Athens campus make up the operational committee. Research is centered around, but not restricted to, the problems of the biological productivity of estuarine waters. Graduate student assistantships are available. Address inquiries to the Graduate School, University of Georgia, Athens.

■ The amount of the grant for the Kimble Methodology research award [*Science* **123**, 455 (16 Mar. 1956)] has been increased from $500 to $1000.

■ The National Science Foundation has awarded 775 predoctoral graduate fellowships in the natural sciences and allied fields for the academic year 1956–57. Successful fellows were selected from 2892 applicants from all parts of the continental United States, Alaska, Hawaii, and Puerto Rico. Honorable mention was accorded 1366 applicants.

In addition to the predoctoral fellowships awarded, the foundation also awarded 80 postdoctoral fellowships.

Of the predoctoral fellowships, 296 awards were made to first-year graduate students, 302 awards were made to graduate students in the intermediate years, and 177 awards to terminal-year predoctoral students. Recipients include 264 persons who have been NSF fellows during the current academic year.

The largest group of predoctoral fellowships, 182, was awarded in chemistry. In other fields the number of awards were as follows: physics 165, engineering sciences 190, mathematical sciences 67, zoology 58, earth sciences 40, psychology 26, biochemistry 25, microbiology 20, botany 16, medical sciences 14, agriculture 11, anthropology 11, genetics 7, astronomy 7, general biology 3, biophysics 3. In addition, 11 awards were made in areas where the natural sciences converge with the social sciences.

Of the postdoctoral awards, 29 were made in the life sciences, 19 in chemistry, 13 in the mathematical sciences, 9 in physics and astronomy, 5 in the earth sciences, and 2 in the engineering sciences.

Predoctoral applicants were required to take examinations for scientific aptitude and achievement. These tests were administered by the Educational Testing Service, Princeton, N.J. The test scores, academic record, and recommendations regarding each candidate's abilities were then considered by panels of outstanding scientists in the respective fields of the candidates. This part of the selection procedure was carried out for the National Science Foundation by the National Research Council.

Candidates for the foundation's postdoctoral fellowships were judged on academic and research records and recommendations by panels of scientists in each field. The review of applications was conducted for the foundation by the National Research Council.

The fellows may attend any accredited nonprofit educational institution of higher learning in the United States or abroad. Predoctoral fellowships carry stipends of $1400 for the first year, $1600 for the intermediate years, and $1800 for the terminal year of graduate study. Postdoctoral fellowships carry a stipend of $3400. All fellowships include additional allowances for dependents, tuition, and other ordinary expenses.

An announcement of the National Science Foundation predoctoral fellowship program for 1957–58 will be made about 1 Oct. 1956. The postdoctoral program will reopen on 15 July 1956 and again on 1 Oct. 1956. Application forms will not be available until the programs are announced.

■ The Damon Runyon Memorial Fund has recently allocated grants totaling $98,700 for cancer research in medical and educational institutions in New York, Washington, D.C., Palm Beach, Fla., Madison, Wis., and Stockholm, Sweden.

In the Laboratories

■ Ground was broken on 15 March for the third building at the research center of the Association of American Railroads on the campus of Illinois Institute of Technology in Chicago.

Designed by Ludwig Mies van der Rohe, the $500,000 building is the latest step in a long-range program to provide complete research facilities for the railroad industry. The structure will be used primarily for rail, track, ballast, detector car, and structural research.

■ Marquardt Aircraft Company will expand its research and development facilities at Van Nuys with a construction program calling for an expenditure of nearly $6 million. Largest expenditure will be for modernization of the Marquardt Jet Laboratory, under U.S. Air Force sponsorship, to meet the need for "free jet" testing of supersonic ramjets under simulated altitude conditions and for high airflow test runs of longer duration, with shorter intervals between tests.

Free jet testing provides external, as well as internal, airflow at the ramjet engine inlet and more accurately simulates supersonic flight performance through direction of the air blast to provide either angle of attack or yaw conditions.

■ A materials and processes laboratory with testing facilities valued in excess of $750,000 has been established at Lynn, Mass., by General Electric Company's medium steam turbine, generator and gear department. The laboratory, occupying close to 25,000 square feet, will have five groups: metallurgical engineering, mechanical engineering, chemistry and insulation engineering, physics and electrical engineering, and auxiliary operations.

■ A new research and administration center is being built by the Corning Glass Works in Corning, N.Y. The project is the largest ever undertaken by the 103-year-old concern, and when it is com-

pleted this fall, the company's research facilities will be more than doubled.

The center will have a nine-story office building, a three-story laboratory and a single-story research workshop. The buildings are rising on a 17-acre site near the Chemung River, adjacent to the Corning Glass Center.

The project is part of a $65 million expansion program. This includes the construction of three plants in Corning and new factories in Albion, Mich., Danville and Harrodsburg, Ky., and Muskogee, Okla.

■ The General Electric Company and the Pacific Gas and Electric Company have decided to build and operate an atomic power plant to serve the San Francisco Bay area.

The plant, which will be located in the Livermore-Pleasanton area of Alameda County, will be completed during 1957 at a cost of between $3 million and $4 million. Initially, it will have a maximum generating capacity of 5000 electric kilowatts, and an ultimate capacity of 10,000 kilowatts or more. The plant will use a nuclear reactor of the boiling water type.

This brings to 15 the number of civilian atomic power plants under construction, in process of design, or proposed in the United States for completion during the period between 1957 and 1962. These plants involve a total expenditure of more than $500-million; industry is prepared to meet approximately half this cost. As presently proposed, the 15 plants will have a total generating capacity of nearly 1 million kilowatts of electric power.

■ The U.S. Atomic Energy Commission has announced that it will add ordnance engineering functions to its weapons development activities in Livermore, Calif. The new function will be carried out by Sandia Corporation, Albuquerque, N.M., in support of the University of California Radiation Laboratory, Livermore. Sandia Corporation plans to build its staff at Livermore to about 250 by July 1957, reaching 800 to 1000 by July 1958. Most of those added will be engineers and draftsmen.

■ Plans for construction of a new plant to produce 7 million gallons of methanol a year have been announced by the Hercules Powder Company. The plant, to cost in excess of $2 million, will be built at Louisiana, Mo., where Hercules now produces 40,000 tons of anhydrous ammonia a year and is completing construction of a pentaerythritol and formaldehyde plant. Methanol, used in the manufacture of antifreeze, solvent, plastics, coatings, drugs, and dyes, is also used to make formaldehyde, principal raw material in the manufacture of pentaerythritol.

■ A new polyvinyl chloride resin plant with a production capacity of about 12 million pounds a year is being built at Leominster, Mass., by the Borden Company. This is Borden's first polyvinyl chloride plant; it will be completed in June.

The plant will produce a wide variety of specialty resins and vinyl chloride latices as well as general-purpose polyvinyl chloride for the calendering and extrusion fields. Manufactured in powder form, the polyvinyl chloride resins find many applications in the production of plastic items. These include calendered sheeting, coated fabrics, electrical wire covering, plastic floorings, surface coatings, phonograph record molding, paper coating, nonwoven fabrics, and leather finishes.

Miscellaneous

■ The National Association of Manufacturers has assembled a survey of industry's support of high-school science, *Tomorrow's Scientists and Engineers.* To secure this brochure, with its suggestions on how to develop future scientists and engineers, write to The National Association of Manufacturers, 2 E. 48 St., New York 17.

■ Calls of 40 insects of the eastern United States are available on a 12-inch, 33⅓ rpm record obtainable from Cornell University Records, a division of Cornell University Press.

This record, "The Songs of Insects," is the ninth of a series of records of wildlife sounds. The calls were recorded by Richard D. Alexander and Donald J. Borror, department of zoology and entomology, Ohio State University, with the assistance of Edward S. Thomas, Ohio Archaeological and Natural History Museum.

■ The best articles from European technical and industrial journals, translated and digested, are now available to American industry. The Organization for European Economic Cooperation, a multigovernment agency set up to stimulate economic growth of member nations, will distribute its monthly publication *Technical Digests* in the United States. The periodical is designed primarily for those interested in manufacturing and production.

The Department of Commerce through its Office of Technical Services is cooperating with O.E.E.C. in making this new source of information available.

■ *Astronautica Acta* is the title of the new journal of the International Astronautical Federation, to which some 30 national societies adhere. In the United States the adherent societies are the *American Rocket Society* and the *American Astronautical Society.*

American members of the publication's advisory board are S. F. Singer of College Park, Maryland; E. R. Bergaust of Arlington, Va.; and H. S. Tsien of Pasadena, Calif.

■ *What's New in Food and Drug Research,* a quarterly bulletin reporting news and information of interest to people in the food, drug and cosmetic fields, is available without charge on letterhead request addressed to Food Research Laboratories, Inc., 48–14 33rd St., Long Island City 1, N.Y.

■ Positions for geophysicists are available in the Coast and Geodetic Survey of the Department of Commerce and in other federal agencies in Washington, D.C., and throughout the United States. A few positions may also be filled overseas. The salaries range from $4345 to $11,610 a year.

To qualify, applicants must have had appropriate education, plus, for positions paying $4930 and above, appropriate professional experience. Graduate study may be substituted for experience. No written test is required.

Applications will be accepted by the Board of U.S. Civil Service Examiners, Coast and Geodetic Survey, Department of Commerce, Washington 25, D.C., until further notice.

■ The following chemicals are wanted by the Registry of Rare Chemicals, Armour Research Foundation of Illinois Institute of Technology, 35 W. 33 St., Chicago 16, Ill.: 3,4-dichlorophenol; 4-amino imidazole; dididecyl selenide; 4-hydroxy piperidine; lithium persulfate; magnesium diboride; ammonium pyrosulfate; azoethane; N-chlorosulfanilic acid; laurylmethylethyl sulfonium iodide; ethyl-*p*-benzoquinone; 2-ethoxyethylamine; 10-ethyl-5,10-dehydrophenarsazine; 1,1,2,2,3,3-hexachloropropane; 1,1,1,2,3,3-hexachloropropane; 4-(2′-hydroxyphenyl)-1,3-butanedione; 3-hydroxyphenylethanol; 3-hydroxyphenyl acetaldehyde; alpha-mycolic acid; methyl hydroxyacetate; and 8-octadecynoic acid.

■ The French Cultural Services will publish bibliographies of French scientific works. The first, which covers the years 1951–53, is now available and will be distributed free of charge from the French Cultural Services, 972 Fifth Ave., New York 21, N.Y.

Reports and Letters

Hypoglycemic Action of Sulfonylureas in Patients with Diabetes Mellitus

Although it has been known since 1941 that a variety of sulfonamide derivatives are effective as hypoglycemic agents in animals, the recent reports by Franke and Fuchs (*1*) and Bertram, Bendfeldt, and Otto (*2*) have stimulated interest in the application of the sulfonamide compounds to the treatment of patients with diabetes mellitus. These investigators demonstrated that the oral administration of sulfanilyl-*n*-butylurea was effective in eliminating the need for exogenous insulin in many adult patients with diabetes mellitus. The subsequent demonstration that the sulfonylureas are noncompetitive inhibitors of the enzyme responsible for the destruction of insulin (insulinase) and that a decrease in insulinase activity is associated with the hypoglycemia that follows the ingestion of the sulfonylurea by rats (*3*), prompted an extension of the afore-mentioned clinical observations (*4*).

The present preliminary report deals with observations on the acute action of 1-butyl-3-*p*-tolylsulfonylurea (*5*) by mouth on the blood sugar of adult patients with diabetes mellitus of various degrees of severity. The tolylsulfonylurea was used in this study because it was found to be more potent than the sulfanilyl-*n*-butylurea in the production of hypoglycemia and insulinase inhibition in the rat (*3*).

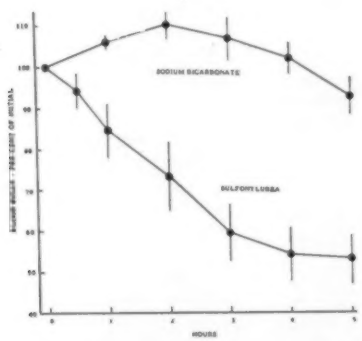

Fig. 1. Hypoglycemic action of tolylsulfonylurea by mouth in adult patients with diabetes mellitus. The blood sugar concentration at each interval was expressed as the percentage of the concentration prior to the ingestion of the solution. The sulfonylurea curve represents the mean ± S.E. of the percentages of the initial blood sugar of 34 patients who showed a decrease in the blood sugar.

The patients varied from 21 to 73 years in age. The age of onset of the metabolic disorder varied from 6 to 65 years and the duration from less than 1 year to 30 years. Those patients who were maintained with long-acting insulins were transferred to regular insulin for 3 to 5 days before the study in order to obviate the effect of insulin depots. All subjects were fasted overnight and were not given any insulin on the morning of the test. Forty-four patients were given 50 mg of the tolylsulfonylurea per kilogram of body weight, as a 2-percent solution in 0.5-percent sodium bicarbonate adjusted to *p*H 8. Twenty-four patients served as controls and were given 5 ml of 0.5-percent sodium bicarbonate per kilogram. Venous blood samples were taken before and at intervals after the ingestion of the solution, and the concentration of glucose was determined by Nelson's procedure (*6*). The blood sugar values for each interval were expressed as the percentage of the pretest value.

A statistically highly significant hypoglycemic response occurred in 34 of the patients with diabetes who were given the sulfonylurea. The mean (± S.E.) response of these 34 subjects is illustrated in Fig. 1. In contrast is the slight increase in blood sugar that occurred in the patients who were given sodium bicarbonate. Five patients showed no decrease in blood sugar after they had taken the sulfonylurea, while five subjects showed a negligible decrease.

The ten subjects who did not respond significantly to the ingestion of the tolylsulfonylurea developed the metabolic disorder before the age of 20 years (mean age of onset ± S.E. = 13.6 ± 1.7 years) and had the syndrome for 8 to 30 years (mean duration ± S.E. = 17.2 ± 2.1 years). Although the response appears to bear a direct relationship to the age at which the diabetic syndrome developed (Fig. 2), the duration of the syndrome also plays a role in determining the response. Thus, calculation of the multiple regression of the mean percentage decrease in the blood sugar during the 5 hours after the sulfonylurea (y) on the age of onset (x_1) and the duration (x_2) of the metabolic syndrome reveals that both variables are involved ($y = 57.8 - 0.64x_1 - 0.28x_2$). The influence of these and other factors on the hypoglycemic response to the sulfonylureas will be considered in greater detail in a subsequent report.

The data reported herein are in complete agreement with those reported by Franke and Fuchs (*1*) and Bertram, Bendfeldt, and Otto (*2*). Further, the data support the hypothesis that the insulin insufficiency of the majority (approximately 75 percent) of patients with diabetes mellitus is due to an increase in the rate of destruction of insulin by the tissues rather than to a marked decrease in the rate of production of insulin by a severely damaged pancreas (*7*). Thus, the tolylsulfonylurea, acting as an insulinase inhibitor, may produce a decrease in the destruction of endogenous insulin with a consequent increase in the availability of insulin and a resultant hypoglycemia. The lack of response of patients in whom the metabolic disorder began in childhood or adolescence and in whom it persisted for many years may be due to exhaustion of the pancreas such as occurs in animals that are chronically exposed to increased demands for insulin by the peripheral tissues.

The usefulness of the sulfonylureas in the treatment of the patient with diabetes mellitus must await extensive clin-

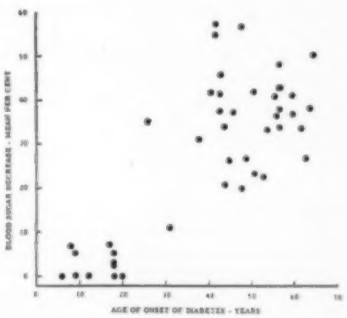

Fig. 2. Relation of age of onset of diabetes mellitus to hypoglycemic response to tolylsulfonylurea by mouth. The decrease in the blood sugar for each subject represents the mean percentage decrease computed from the five hourly samples that were taken after the ingestion of the tolylsulfonylurea.

ical trial. Such trial, however, should be performed with caution since the sulfonylureas are noncompetitive rather than competitive inhibitors of insulinase.

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23 February 1956

Orinase, a New Oral Hypoglycemic Compound

The necessity for the parenteral administration of insulin has stimulated the search for a drug that would be effective by oral administration for the treatment of diabetes mellitus. Recent reports by Franke and Fuchs (*1*), Achelis and Hardebeck (*2*) and Bertram, Bendfeldt, and Otto (*3*) have indicated that 1-butyl-3-sulfanilylurea causes reduction of blood sugar after oral administration. A related synthetic compound, different in that a methyl group is substituted for the *p*-amino group, has also been shown to cause a hypoglycemic response after oral administration to rats, dogs, rabbits, and human beings (*4*). This compound, 1-butyl-3-*p*-tolylsulfonylurea, is called Orinase (*5*) and is the subject of the present report.

Intact male rats weighing approximately 150 g were used for blood sugar and glycogen studies. These were obtained from the Upjohn colony (Sprague-Dawley ancestry). The animals were fasted 24 hours prior to oral administration of the drug and were also without food during the experimental period. Rat blood sugars were determined at intervals during a 15-hour period by the micro method of Shaffer and Williams (*6*), using tail blood. Groups of control and treated rats (five to ten each) were sacrificed after each determination. Since preliminary experiments indicated that 270 mg/kg was the optimal dosage of Orinase for a 150-g rat, the treated animals were given this amount of drug suspended in 0.5 ml of a 1-percent sodium carboxymethyl cellulose solution. Control rats were given the vehicle alone. Liver and muscle glycogen levels were determined by the anthrone method as described by Seifter and Dayton (*7*) on tissues removed 7 hours following the administration of the drug. Results obtained from animals given crystalline insulin in 0.2 ml of saline, injected subcutaneously, are shown for comparison.

Blood sugars in dogs and rabbits were determined (*8*) by the method of Folin and Wu (*9*). Both species were fasted 15 hours before the initial blood sample was taken, and after Orinase (or its sodium salt) was administered, they were continued without food during the entire experimental period. In dogs, blood sugars were run on starving controls at each blood-sampling period so that changes in blood sugar due to starvation alone could be considered in evaluating the hypoglycemia induced. Plasma levels of Orinase were followed by a new procedure based on the spectrophotometric measurement of the ultraviolet absorption of the drug after extraction from plasma (*10*).

Orinase produced substantial decreases in fasting blood sugar levels when compared with control rats at ½ hour; this decrease was maintained for at least 6 hours (Fig. 1). At 12 and 15 hours, the blood sugars were slightly higher than they were for the controls. It is of interest that at 7 hours the liver glycogen was increased in the Orinase-treated animals (Table 1), whereas the muscle glycogen was not changed from the control value. In contrast, insulin produced a substantial increase in muscle glycogen with no consistent change in liver glycogen. These results suggest a difference in mechanism of action between Orinase and injected insulin. Further, it is important to recall that Synthalin, essentially a liver poison, produces a depression of liver glycogen (*11*), indicating that Orinase acts via a different mechanism than Synthalin. From the data in Fig. 1 and Table 1, it is apparent that blood sugar levels decreased while liver glycogen increased. This suggests that in the rat one of the primary sites of drug action is the liver. This hypothesis is being tested by administering Orinase to hepatectomized and eviscerated rats under various experimental conditions.

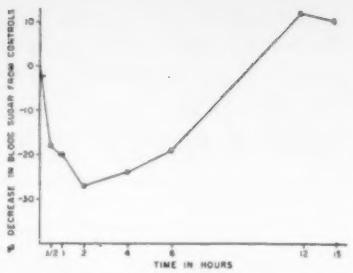

Fig. 1. Effects of a single oral dose of Orinase (270 mg/kg) on fasting blood sugar levels in the rat.

Table 1. Comparison of orally administered Orinase and subcutaneous insulin on liver and muscle glycogen of intact fasting rats.

Treatment	No. of animals	Glycogen (%)	
		Liver	Muscle
Controls	23	0.21	0.31
Orinase, 270 mg/kg	22	0.51	0.28
Controls	10	0.34	0.40
Insulin, 6.7 units/kg	10	0.48	0.65
Insulin, 13.4 units/kg	8	0.34	0.82

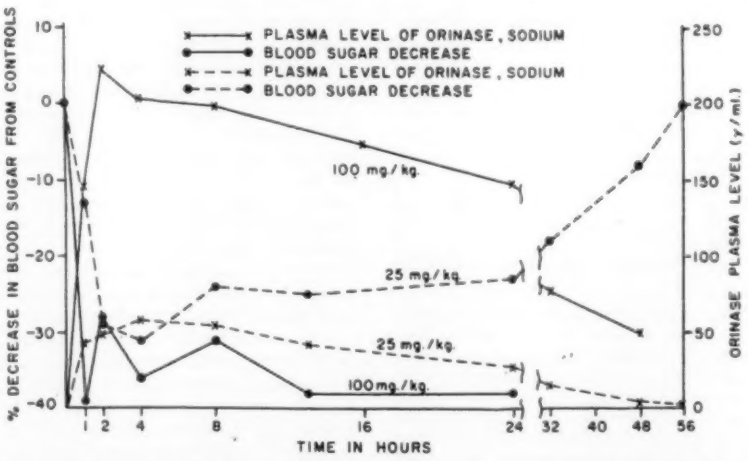

Fig. 2. Relationship of blood sugar decrease to plasma concentration of Orinase (sodium salt) after a single oral dose to fasting dogs. Each point represents an average of values determined from three dogs at each dose level; six dogs were used in all.

In the dog, both Orinase and its sodium salt were studied. They were equally effective in maintaining a lowered blood sugar, but the water-soluble salt decreased the blood sugar more rapidly. A single dose of 25 mg/kg of the sodium salt decreased and maintained the blood sugar of a normal starving dog at a level 25 to 30 percent below controls for at least 24 to 32 hours. When 100 mg/kg was given, a decrease of about 40 percent was observed for at least 32 hours (Fig. 2). Although 600 mg/kg produced a blood sugar depression no greater than 100 mg/kg, this dose caused death within 20 hours.

Rabbits that were given 400 mg/kg of the sodium salt of Orinase responded with maximum blood sugar depressions similar to those obtained with 100 mg/kg in dogs. The rate of recovery from hypoglycemia in these rabbits, however, was comparable to that in dogs that were given only 5 to 15 mg/kg. The lethal dose for rabbits was approximately 3500 mg/kg and, as in dogs, death was not the result of hypoglycemia.

Determinations of the plasma level of the drug in dogs that were given oral doses at levels of 5, 15, 25, 100 and 600 mg/kg indicated that at the peak plasma levels, about 10 percent of the dose can be found in the plasma (Fig. 2). The times required to clear the plasma of the drug were about 24, 48, and 72 hours for doses of 5, 25, and 100 mg/kg, respectively.

Chronic toxicity studies in several species are now in progress (*12*). Weanling rats of both sexes have been fed the drug for 8 weeks at approximately 100, 200, and 400 mg/kg, and no significant weight changes were seen when compared with controls. At 4 weeks, no change in the hemograms was apparent, but a moderate enlargement of the thyroid gland was observed in all rats that were given the higher doses.

The mechanism of action of Orinase has not been resolved at the present time, but it does affect the mechanisms involved in the deposition of liver glycogen in the fasting rat. The effect of Orinase on pancreatic function and on the peripheral action of endogenous insulin and glucagon is under study.

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WILLIAM E. DULIN

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23 February 1956

Insulin-Sparing Sulfonamides

An orally administered sulfonamide has been found to lower the blood sugar in normal individuals and in patients with "mild" diabetes (*1*). Toxic effects have been minimal or absent.

The present report (*2*) summarizes some observations of clinical interest in ten patients who have received one or both of two such sulfonamides (*3*). Six were "severe" diabetics, and four were "mild" diabetics. Three of the former and one of the latter have been studied under precisely controlled conditions on the metabolic ward.

Three of the five "severe" diabetics had very significant *decrease* in insulin requirement and/or lowering of blood or urine sugar on a constant dose of insulin. Two grams or more of sulfonamide per day were required to produce this effect. One "severe" diabetic on chemically constant intake had a significant *increase* in glycosuria during sulfonamide administration. The fifth "severe" diabetic had essentially no demonstrable effect.

Three middle-aged obese diabetics had more than 50-percent reduction in insulin requirement with sulfonamide administration of less than 2 g daily. One mild diabetic, maintained on chemically constant intake (without insulin), had a 50-percent reduction in blood sugar level during the day on which she received a single dose of 3 g of sulfonamide. A very diabetic glucose-tolerance curve reverted to normal following a single dose of 6 g of sulfonamide in one "preclinical" diabetic.

Twenty-four-hour iodine-131 uptake by the thyroid was diminished to less than 5-percent during intensive sulfonamide administration in three severe diabetics. With reduction in dosage, the uptake returned to a normal level.

In the three "severe" diabetics who responded favorably, a reciprocal relationship between blood free sulfonamide and blood sugar levels was noted.

In two "severe" juvenile diabetics, one of whom had profoundly favorable modification of the diabetic state, and the other of whom had a significant increase in glycosuria during sulfonamide administration, all of the administered sulfonamide could be accounted for in the urine. In the former, the greater portion of urinary sulfonamide was conjugated; in the latter, the greater portion was free.

Decrease in circulating granulocytes was noted during the administration of very large dosages of sulfonamides. Marrow findings were interpreted as showing maturation arrest (William Chew). The blood count returned to normal when medication was decreased or stopped.

The foregoing observations confirm the results recently reported by German investigators in patients with "benign" diabetes. In addition, the sulfonamides favorably modify the diabetic state in some severe diabetics. Significant differences in free and conjugated sulfonamide excretion, respectively, have been noted in severe diabetics who do and who do not respond favorably to sulfonamide. This suggests that differential metabolism of administered sulfonamide may be partly or completely responsible for the type of therapeutic response.

Large dosage may result in toxic manifestations. Reduction of dosage, thus far, has been associated with disappearance of such manifestations.

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2. We wish to acknowledge the technical assistance of Marjorie Coelho, George Fukayama, Florence Olson, and Evalyn Jones.
3. The two sulfonamides that have been used are BZ-55 (N_1-sulfanilyl-N_4-*n*-butyl-carbamide) and Orinase (a compound identical with BZ-55 except for the substitution of a methyl for the amino group on the benzene ring). Orinase was administered in doses ranging from 1 to 6 g/day. BZ-55 was administered in doses ranging from 1 to 16 g/day. Grateful acknowledgment is made to C. J. O'Donovan of the Upjohn Company for supplies of both preparations and to W. R. Kirtley of the Lilly Research Laboratories for supplies of BZ-55.

7 March 1956

Black Pigment Concentrating Factor in the Fiddler Crab

The production of both a body-lightening and body-darkening blood-borne factor by a crab has not been demonstrated although such antagonistic hormones are known in other crustaceans (*1*). All crabs that have been examined with the exception of three species of the genus *Sesarma* blanch following eyestalk removal (*2*).

The chromatophore system of the fiddler crab, *Uca*, has been the subject of several investigations. This crab blanches following the removal of its eyestalks. Extracts of the eyestalks (*3*) and central nervous organs (*4*) of *Uca* have darkening potency only. Several groups of investigators (*5*, *6*) have postulated a *Uca*-lightening hormone. The results of their experiments could be explained more simply by assuming that body lightening was due to a body-lightening hormone rather than to removal of the darkening hormone from the circulation. The following assumptions have also been made: (i) the darkening factor antagonizes the lightening factor so completely in a mixture of the two factors that only the darkening factor is able to express itself; (ii) when the crabs are dark there is a predominance of darkening hormone in the blood; (iii) when the animal is light there is an abundance of a lightening hormone in the blood. Transfusion of blood from a light crab to a dark crab has not confirmed the last assumption.

The experiment described here (*7*) was designed to demonstrate by perfusion the existence of body-lightening and body-darkening factors in the blood of the fiddler crab, *Uca pugilator*. The specimens were collected at Ocean Springs, Miss. *Uca* from the stocks in the laboratory were separated into two groups. The pigment in the melanophores of one group was maximally concentrated and in the second group the pigment was maximally dispersed. A crab whose melanin was maximally dispersed was induced to autotomize three walking legs. The most distal segment of each leg was then transected to facilitate perfusion. Each leg was then placed in sea water in separate Syracuse watch glasses. The first leg was perfused with 0.05 ml of blood taken from a *Uca* whose melanin was maximally concentrated. The second leg was perfused with 0.05 ml of blood from a *Uca* whose melanin was maximally dispersed. The third leg was perfused with 0.05 ml of sea water.

The chromatophore scale of Hogben and Slome (*8*) was used to stage the chromatophores. Stage 1 represents maximal pigment concentration, stage 5 maximal dispersion, and stages 2, 3, and 4 intermediate states of pigment dispersion. The stage of the chromatophores on the isolated legs was determined at 15, 30, and 60 minutes following the perfusion.

This experiment was performed 15 times. The averages for all the experiments are presented in Fig. 1. The results produced a family of curves. The pigment in the chromatophores on the legs of *Uca* gradually concentrates following isolation, as had been demonstrated previously (*6*). The pigment in the legs perfused with sea water concentrated slowly (curve *B*). Perfusion with blood from dark *Uca* slowed the rate of lightening as compared with the control legs (curve *A*). Perfusion with blood from a maximally light *Uca* caused a more rapid rate of concentration of the pigment in the isolated chromatophores than was observed in the controls (curve *C*).

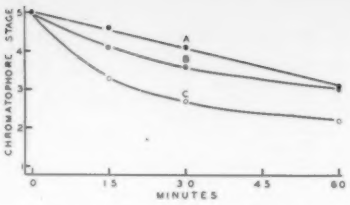

Fig. 1. State of dispersion of the pigment in the melanophores of isolated legs of the fiddler crab, *Uca pugilator*. (*A*) Legs perfused with blood from a maximally dark crab; (*B*) control, legs perfused with sea water; (*C*) legs perfused with blood from a maximally light crab.

These results could not have been obtained unless a lightening factor had been present in the blood of the pale *Uca* and a darkening factor had been present in the blood of the dark *Uca*.

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26 September 1955

Detection of Complement-Fixing Antibodies for Carré's Virus

Carré's virus (canine distemper virus) produces the most common disease syndrome of the domestic dog, and it has also been suggested that it is capable of producing disease in the human being (*1*, *2*). Adams (*2*) has discussed the virus in relation to a specific respiratory disease process of man. Serologic techniques have been used for the detection of antibodies against the virus for many years. Early descriptions of complement-fixation and neutralization tests were given by Laidlaw and Dunkin (*3*), Pyle and Brown (*4*), and others (*5*). Little improvement was made in the basic techniques described by these early authors until Haig (*6*) discovered that Carré's virus could be adapted to the chorioallantoic membrane of the developing chick embryo. Cabasso and Cox (*7*) developed a serum neutralization test using this method.

Serum neutralization tests have the disadvantages of requiring large numbers of eggs or animals and, for the average laboratory, limiting the number of tests that can be done according to space and equipment. However, the increased interest in Carré's virus creates a need for a standard serologic test in order to compare and evaluate the results obtained in various laboratories. This report describes an antigen that can be used in a complement-fixation procedure that can be performed in most laboratories with minimal serologic equipment. It is interesting to note that since the completion of this work, Morris, Aulisio, and McCown (*8*) have described similar experiments that corroborate, in part, our results.

Seven-day-old embryonated chick eggs were used in preparation of the antigen. They were inoculated on the CA membrane with 0.1 ml of a 20-percent suspension of infected membranes. This material was prepared by removing membranes that showed a diffuse area of infection from eggs that had been inoculated 7 days previously. The membranes were ground in a blendor with enough saline to make a 20-percent suspension by weight. After 7 days' incubation at 37°C, the shells were removed, and membranes that showed multiple lesions were used for antigen production. Membranes were pooled, quick frozen, and stored at −20°C for at least 48 hours. After thawing, a 40-percent membrane suspension in buffered (*p*H 7.2) saline was made in a Waring-type blendor. Heavy particles were removed by centrifugation, and the supernatant fluids were stored in sealed ampoules. Normal membranes were similarly processed as control antigens.

Antiserums used in these trials were either stored at −20°C immediately after removal from the clot or first passed through a Seitz filter. Positive control serums were prepared by hyper-immunization of dogs with attenuated virus in ferret spleen preparations. The techniques of the tests were essentially the standard procedures described by Kolmer and Boerner (*9*). Overnight incubation at 5°C was employed in all cases.

Repeated titrations demonstrated that nonspecific reactions do not usually occur above a 1/8 dilution of serum. A 1/8 or 1/16 dilution appears to be satisfactory for single-tube screening-type tests. Positive reactions below this dilution are of doubtful significance. All positive serums should be titrated to determine endpoints.

Preliminary studies with the antigen in

the examination of human serum have indicated the presence of complement-fixing antibodies of significant level in some cases. In a group of 20 samples of normal individuals taken at random, 35 percent showed the presence of antibodies. In a group of 35 samples from patients with nonbacterial respiratory disease, the reaction level was 3 percent. In similar examination of 63 canine samples, where the reaction rate would be expected to be higher, a positive percentage of 45 was obtained.

There is no doubt that serologic methods for identification of Carré's virus antibodies require further improvement. An antigen giving specific reactions in greater serum dilution would be very advantageous. Perhaps more highly purified preparations would be more efficient. Adaptation of the virus to tissue culture may help solve some of these problems. With the realization of probable public health significance of the virus, the need for further immunologic and serologic studies is reemphasized.

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26 September 1955

Observations at an Ancient Smelting Site in Negev

Prospecting for copper and other metals in Timnah area, Negev, is leading us to a closer study of some ancient mining and smelting sites. A reconstruction of ancient prospecting, mining, and smelting practices may prove to be of use in our current exploration. The present advance note (*1*) deals with some of our findings at a smelting acropolis (*2*) in the central part of Wadi Timnah (Meneiyeh Um Adak). A more detailed account is to be submitted elsewhere for publication (*3*).

Table 1. Chemical analysis of ores found in the Timnah acropolis (percentage of original sample). ND, not detected; P, Ti, HCl-soluble S, SO_4, and water-soluble Cl were not detected in any of the ores.

No.	CuO	MnO	Fe_2O_3	Al_2O_3	CaO	MgO	SiO_2	CO_2	Cl	Loss at 1100°C
348/55	19.3	0.09	23.9	1.3	1.4	0.4	43.2	3.9	0.8	12.5
349/55	23.4	ND	2.0	1.1	0.6	0.1	62.2	5.8	0.3	10.8
350/55	20.1	ND	3.3	0.9	7.8	0.2	52.1	10.6	0.3	16.0
351/55	24.2	ND	0.8	1.0	0.8	0.3	61.4	5.8	0.7	11.7
352/55	29.3	ND	0.6	1.1	0.7	0.3	54.8	7.8	0.1	14.9

Table 2. Some chemical data on concretionary copper ores containing chalcocite (percentage of original sample).

No.	Cu	S	SiO_2	CO_2	Cl	Loss at 1000°C
1416/55	38.5	2.4	35.4	8.9	1.95	18.4
1417/55	62.8	10.8	6.3	6.2	4.77	23.7
1029/55	58.7	6.9				
78/52	67.3	14.1		8.3		

The composition of the ancient ores and slags here reported poses more problems than it solves. Our success in following the ancient trails to the apparent sources of the ores found in the acropolis is in need of further evaluation. The quality of ancient slags and their remarkably high melting ranges (*4*) need to be reconciled with current views of ancient metallurgy. Finally, the out-of-place materials, other than artifacts, found in the acropolis cannot be accounted for in the present state of our knowledge. However, a preliminary report is not devoid of interest, in view of the cultural-historical importance of the area and the insufficiency of contemporary archeological knowledge.

Notwithstanding the opinion of such scholars as Glueck (*2*, pp. 77–79), mining in Timnah could not have been arduous at any time. Outcrops and tunnels utilized by our predecessors in mining required more skill than manpower in their discovery and development (*5*). Smelting of the ancient copper ores required far more skill than brawn, judging by the quality of the slags and of the finished products. Fuels and flux materials were procurable apparently within a short distance of the smelting site. The climate was pleasant in winter and easily tolerable in summer, even as it is now. All the operations for the production of copper in the ancient times could be accomplished by a handful of laborers, a few skilled technicians, and the military guard—essential then as it is today.

The acropolis containing ash and slag heaps is situated on a flat top of an isolated hill of white sandstone in the central part of the wadi. The hill is a rectangle, about 1000 by 400 feet, with vertical slopes about 100 feet high above the surface of the wadi. The hill can be ascended by one of the two paths cut or worn in the rock or by a talus slope from the south, by the side of a sand-filled cave now concealed by boulders and poorly accessible. The acropolis was visited by us five times in 1954–55. Collections of suitable materials were made for subsequent studies, and the largest slag heap was excavated in two places, to the sandstone floor of the hilltop.

Three types of materials were especially interesting in the earlier exploration: (i) fragments of copper ore on the surface of the ground and in the heaps, all of a uniform size but of five different kinds, morphologically; (ii) fragments of slag of two different kinds but of a rather small and uniform size, in contrast with other slag heaps in the area; and (iii) the out-of-place materials (*6*), notably fragments and masses of red sandstone and conglomerate containing small amounts of gold, as well as some other kinds of materials, including large crystals of calcite the sources of which are still undiscovered.

Fragments of the copper ores found in the acropolis were grouped into five categories, on the basis of their appearance and of the associated rock. The chemical analysis (*7*) of these ores is given in Table 1.

Outcrops of copper ore resembling the five kinds found in the acropolis were located by us within a short distance of the site, after a detailed search, involving utilization of ancient trails (along which sparse fragments of ores, calcite, and other materials were scattered), the normal dispersion trains, and other prospecting leads. Significantly, no chalcocite copper was found in the acropolis and it is possible that none was taken by the ancients of the acropolis from the outcrops or the wadis, despite its high copper content (Table 2) and its fairly common presence in some alluviums.

Table 3. Comparison between some chemical constituents of slags and copper ores (percentage of original sample); cobalt and lead were not detected in the slags.

No.	Material	Cu	Fe	Mn	Cl	P_2O_5	CaO	MgO
136/55	Porous slag	1.74	35.6	2.71	0.1	0.72	4.17	1.04
137/55	Massive slag	1.55	35.3	2.74	0.06	1.05	4.68	1.11
348/55 through 352/55	Copper ores	15–23	0.4–17	0–0.07	0.1–0.8		0.8–7.8	0.1–0.4

Two kinds of black slag are found in the ash heaps of the acropolis, massive and porous. They are found in relatively small fragments, as a rule, in contrast to the large and irregular pieces of slag found at the foot of the acropolis, within an enclosure, and elsewhere in the area. It is not clear whether the slag in the acropolis was fragmented by man or by the natural agencies. If it was fragmented by man, the purpose of the operation is obscure. Melting points of both kinds of slag are the same, about 1250°C and higher—a remarkably high temperature. Their chemical composition is nearly the same (Table 3).

The discrepancy between the manganese content of the slags and of the copper ores is significant enough to make one doubt any relationship between the two materials, to doubt possibly the very supposition that it was copper that was melted in the acropolis, unless one could prove that manganiferous materials were used in the smelting flux (*8*). No such materials were found by us there, except a few rounded fragments of a manganese-quartz conglomerate. Studies now in progress may help clarify this and other problems posed by our preliminary findings.

Archeological-historical understanding of the ancient metallurgical skills is not possible without detailed chemical analysis and experiments in the laboratory and a full accounting in the field for all materials in the acropolis—that is, for the sources of ores, fluxes, and the out-of-place rock. Our interest is not in the scale of the operations but in their quality and kind, the more so since the acropolis seems to be unique among the smelting sites of southern Negev in regard to the materials it contains and the kind of operations their presence implies.

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1. Published by permission of the director, Machzavei Israel (Israel Mining and Industries).
2. A superficial description of this site is given by N. Glueck, in *The Other Side of Jordan* (American Schools of Oriental Studies, New Haven, Conn., 1940), p. 79.
3. The district may have been worked repeatedly, both before and after the reign of King Solomon.
4. The incipient white range; we are indebted to M. Chvalov of the Technion, Haifa, for these measurements.
5. According to Glueck, (2, p. 77) "Cupriferous sandstone protrudes all over the surface of the entire wadi." This is far from being the case. Outcrops of mineralized rock were not easy to find in Timnah, after extensive studies by a sequence of geologists. Some outcrops were found only recently and others remain inferred rather than proved. The wadi floors are chiefly alluvium, with only occasional fragments of concretionary copper ore of the kind that *was not* smelted by the ancients, despite its high copper content. The protrusions of cuprite and malachite mentioned by Glueck still remain to be found.
6. Not including the artifacts: a few blades of flint of a highly skilled workmanship; potsherds of different kinds, thicknesses, and modes of tempering and firing; grinding stones; mortar slabs; egg tray-like slabs of obscure origin or use; and so forth. Weathered fragments of large marine shells and bones of desert animals were found in bonfire residues, among other things.
7. We are indebted to A. Alon and Y. Mashal for the chemical data in this report, and to Nevies for analysis No. 78/52.
8. A. Dor and Y. Cohen, of the Machzavei Israel, succeeded in smelting a chrysocolla ore from Timnah using a charcoal, calcium carbonate flux.

26 September 1955

Cocarcinogens and Minimal Carcinogenic Doses

The concept of cocarcinogenesis originated in 1938, when it was reported that a coal tar distillate, the basic fraction of a creosote oil, was capable of enhancing the activity of 3,4-benzopyrene on mice even though alone it did not give rise to tumors after skin painting or subcutaneous injection (*1*). Since the fraction did not appear to be carcinogenic, it was termed a "cocarcinogen." Subsequent studies with croton oil, croton resin, ultraviolet light, ionizing radiation, trauma, heat, and burns established those agents as experimental cocarcinogens for the mouse and led to acceptance of the term to apply to physical or chemical agents that are noncarcinogenic but which enhance the effect of a carcinogen, especially when the carcinogen is weak or applied at too low a level to produce tumors (*2, 3*).

Recognized tumor-inducing agents also have been used experimentally as cocarcinogens on the assumption that they were applied at so-called "minimal" or "subminimal" levels. It was supposed that they could not both "initiate" and "promote" neoplastic changes at low dosages in normal cells; their action was interpreted to be only that of "promoting" the growth potential of cells already rendered neoplastic by some preceding mechanism.

With the recent demonstrations that almost all heretofore identified cocarcinogens are capable of both initiating and promoting the growth of tumors (*4*), it would appear that, with the possible exception of trauma, what have been termed cocarcinogens are probably tumor-inducing agents tested under conditions that did not disclose their potency as tumor initiators. It appears timely therefore to question what is meant by "minimal," "subminimal," "initiating," and "promoting" doses when a known tumor-inducing agent is involved.

A technique frequently employed in experiments on cocarcinogenicity involves the application of a single subminimal carcinogenic stimulus to a selected site of the experimental animal to initiate a neoplastic change; this is followed by repeated applications of a cocarcinogen to promote the development of a grossly visible tumor from the initiated, but latent neoplastic cells. An experiment (*5*) to study the individual effects of the initiating and promoting dose with the carcinogen 3,4-benzopyrene is illustrated in Table 1. In that experiment, one group of mice received on the shaved interscapular skin a 0.01-ml drop of 1.25-percent benzopyrene in benzene. This provided approximately 125 μg of the carcinogen as a single subminimal dose. To a second group of mice, an estimated total of 120 μg was applied as a promoting agent in a dosage form of approximately 1 μg of 3,4-benzopyrene in benzene three times weekly for 40 weeks. The absence of any interscapular tumors in the first group is in sharp contrast with tumor induction in 9 of 42 mice in the second group by the 40th week of the experiment. Thus, depending on dosage and duration of exposure, the total amount involved in a subminimal acute exposure was more than adequate for tumor induction when exposures involved fractions of the total dose administered repeatedly. These results, obtained with a percutaneously applied carcinogen, parallel the observation that repeated oral doses of CCl_4 produced hepatomas in mice, whereas an equal total amount given in one dose did not (*6*). The factors of dosage and

Table 1. Tumor induction following single and repeated exposures to equal amounts of 3,4-benzopyrene in benzene.

3,4-Benzopyrene (μg per application)	Applications (No.)	Tumors after 40 wk (%)
125	1	None
1	120*	20 (9/42)

* Applied three times per week to interscapular skin of C57/Bl male mice.

Table 2. Skin tumor induction following repeated exposures to approximately 1 μg of 3,4-benzopyrene that was applied percutaneously three times per week.

Mice		Weeks preceding tumor appearance												Mice with no tumors*
Strain	No.	30	35	40	45	50	55	60	65	70	75	80	85	
C57BL	13	1	2				1	1		2	1		4	1
DBA/2	13					1	1	1	1	1	1	1		6
CAF_1	12							1	1	1	1			6

* Nontumor deaths after the 30th week.

exposure time are essentials that have been omitted previously in proposed methods for assaying comparative carcinogenic potency (*7*). In the absence of experimental verification, the exposure level at which a carcinogen ceases to have "initiating potency" and retains only "promoting action" cannot be predicted at this time.

From the early studies in experimental carcinogenesis, there has been general acceptance of 0.3 percent as providing a standard low concentration of carcinogenic hydrocarbon dissolved in benzene for skin painting experiments (*8*). An indication that 0.3 percent is in fact a high concentration of carcinogen may be found as early as 1940, when, despite reference to the concentrations used as minimal doses of carcinogen, tumors were reported in 18 of 20 mice that had been painted with a 0.05-percent solution and in 14 of 20 mice that had been painted with a 0.02-percent solution of benzopyrene in benzene (*9*). In our laboratory, the tumor-inducing potency of even lower concentrations was demonstrated with the application of 1 μg or less of benzopyrene as a 0.01-percent solution in benzene three times weekly for the life span of the animal or until a tumor was induced (Table 2). Evidently, when solutions of 0.01-percent benzopyrene applied in microgram or lesser quantities induce tumors in 50 to 100 percent of exposed mice during their life span, such terms as *low standard concentration, minimal dose* of carcinogen, *initiator, promotor,* and *cocarcinogen* need to be redefined in quantitative terms.

It cannot be denied that cocarcinogens may exist, with roles in carcinogenesis comparable to that of pharmacologic adjuvants and physiologic or chemical catalysts. But their existence is yet to be conclusively demonstrated by the experimental oncologist.

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26 September 1955

Preliminary Report on Biological Applications of Color Television

Electronic image processing (*1*) is the term we have used to describe a variety of electronic means for viewing objects or processes and picturing these in their original or in altered but meaningful forms. These techniques have been of particular interest to us when they permit visualization of biological phenomena that cannot otherwise be seen, or when the electronic systems employed bring out information that is concealed when the phenomena are viewed directly. Such systems are analogous to indicator systems used in morphological studies, such as stains.

Color television has been explored as one of these electronic image-processing techniques that can be applied to biological problems. Sixteen millimeter color kinescope (motion-picture) film records of a pilot experiment indicate that some theoretical advantages of this technique can be realized. An amphibian preparation (frog) was set up in the C.B.S. Studios in New York on 10 Apr. 1955, by Louise Warner of Georgetown University Medical School and Edward H. Bloch of the Western Reserve University School of Medicine; the quartz-rod illumination technique was employed. This preparation was selected because it is simple, the results are reproducible, and direct motion-picture records by this technique are familiar to investigators in the field of microscopic circulation as well as readily available for comparison by others. The C.B.S. color system was employed because it is a completely engineered system with inherent adaptability for these experimental purposes, and a fully developed kinescope recorder is available.

Microscopic circulation in frog mesentery and liver can be observed in normal color relationships at satisfactory magnifications and with good resolution. When lighting is reduced below levels for microcinematography, satisfactory films are obtained. Reductions in the Kelvin temperature of the light source can be compensated without sacrifice in the final picture. Thermal energy delivered to the tissue can be reduced to low levels, thus simplifying the problem of maintaining physiological conditions.

At will, the investigators could remove one or two colors from the picture and record the remaining color or colors. Gamma (the degree of contrast) could be varied independently for each color. "Crispening" circuits were employed to increase apparent contrast. Phase shifts between the camera color wheel and the monitor and recorder color wheels made it possible to record red subject matter as green or blue. The investigators could observe the exact picture that was being recorded on a monitor that was conveniently located near the subject material.

Examination of kinescope film made during this pilot experiment with unmodified equipment indicates that combinations of the afore-mentioned variables produce color motion-picture film that contains usable information that is not available by direct photography.

The extreme sensitivity to light that is an inherent property of such systems makes it conceivable that undisturbed human circulation can be observed and recorded at usefully high magnifications in the retina of man. With the substitution of appropriate filters for the color disks in the camera, chemical data could be correlated with living morphology in those instances in which dissociated light-transmission curves have chemical significance, as in the case of reduced and oxyhemoglobin.

The experimental film has been organized into a short motion-picture entitled, *Color Image Processing, Experiment 26, Joint Study of Electronic Image Processing.* It is one of 26 experiments conducted by the Special Devices Center, Office of Naval Research, U.S. Navy, and the National Institutes of Health, Department of Health, Education, and Welfare, in the course of the first part of a study of the usefulness of television and related techniques in the medical research environment.

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Note

1. The term *image processing* was introduced in the electronic literature by L. S. G. Kovasznay and H. M. Joseph (*Proc. I.R.E.* 43, No. 5, 1955) to describe electronic techniques for sharpening photographic images. We have borrowed and expanded the term to describe the larger field defined in this communication.

10 October 1955

Scopoletin in Differentiating and Nondifferentiating Cultured Tobacco Tissue

Two morphologically distinct strains of cultured tobacco tissue, when extracted with ether, yield markedly different amounts of a fluorescent material. These two strains have been cultured for 5 years and are of a similar (but not identical) origin, being derived from root tumors on two separate seedlings of *Nicotiana affinis* (*1*). Both strains first grew as undifferentiated callus for 3 years. Strain 20-B then started to produce buds and has continued to do so for 2 years, while strain 3-S, which was cultured on the same medium and under the same conditions, has continued to grow as undifferentiated callus with occasional wound tracheids (Fig. 1). More recently, a substrain of 20-B, called 20-B-O, which has reverted to the original nondifferentiating condition, has been isolated (*2*). The tissues are all maintained in diffuse light at room temperature on a modified White's medium containing 3 g/lit of yeast extract.

The tissues were extracted with 2.5 ml of freshly distilled ethyl ether per gram of fresh weight for 16 hours in the cold room. Dry weights were determined on samples of tissue similar to those extracted. The materials present in the ether extracts were chromatographed on Whatman No. 1 paper with water as the ascending solvent. The fluorescent material, visible under ultraviolet light, moved as a distinct band and was eluted with ethyl alcohol. Optical densities of this eluted material were measured at 345 mμ in a Beckman spectrophotometer. For reasons given in a subsequent paragraph, the substance was presumed to be scopoletin, and concentrations were calculated using a molar extinction coefficient of 14,000 determined by Goodwin (*3*) for solutions of this compound.

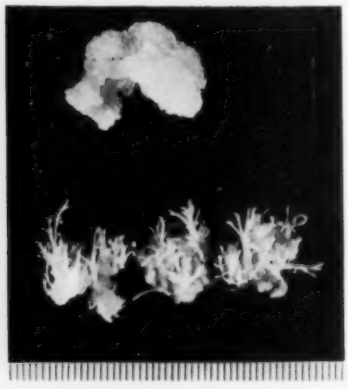

Fig. 1. Two strains of cultured tobacco tissue. (Top) Undifferentiated callus of strain 3-S; (bottom) differentiated shoots on strain 20-B. Scale in millimeters.

The results of the analyses are shown in Fig. 2. The figures are undoubtedly low estimates of the amounts of the compound present in the tissues, since the substance is light-labile, and other losses occur in the elution process. Each bar represents a mean of 12 extractions, with the standard deviation indicated. By the methods used, approximately 18 times as much of the fluorescent compound is extracted from tissue that produces organized structures (strain 20-B) as from tissue that has never so differentiated (strain 3-S). About 6 times as much is extracted from the differentiating strain as from its nondifferentiating substrain (20-B-O). Hot and cold acidic and basic aqueous extractions of macerated and unmacerated tissue yield similar relative differences.

On filter-paper chromatograms, the extracted fluorescent material moves with spots of known scopoletin (6-methoxy-7-hydroxy coumarin) giving R_f values of approximately 0.9 in butanol-acetic acid-water, and approximately 0.34 in butanol-ammonia-water (*4*). The fluorescent material, when eluted from the chromatograms with 95-percent ethanol, has an absorption spectrum that coincides with that reported by Goodwin (*3*) for scopoletin, and with the spectrum of known scopoletin determined simultaneously in alcoholic solution. Identical spectra were obtained for five separate preparations at various concentrations. Figure 3 shows one of these. The same absorption spectrum is observed in material prepared according to Best (*5*), followed by column chromatography on alumina (*3*). Four characteristic maxima occur at 230, 254, 300 and 345 mμ. Both known scopoletin and the extracted material give a green-fluorescent spot on paper chromatograms in basic solvents in daylight, but no daylight-visible spot in acidic solvents. These properties of the fluorescent material are accepted as good indirect evidence that it is indeed scopoletin.

Thus it appears that in these tissues, under the stated conditions of culture, scopoletin is associated with the presence of structures in which much differentiation exists. Similarly, Goodwin and Pollock (*6*) have observed that scopoletin occurs in *Avena* roots in relative abundance only in older parts where tissue differentiation is occurring. Whether the presence of scopoletin is a prerequisite for the formation of the organized structure or the organized structure produces the scopoletin is a question under investigation.

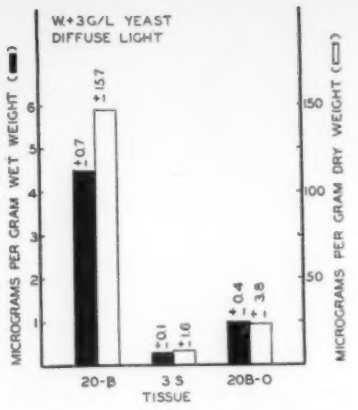

Fig. 2. Amounts of "scopoletin" extracted from three strains of tissue. The figures at the ends of the bars are standard deviations

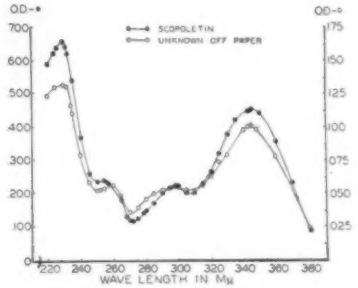

Fig. 3. Absorption spectra of known scopoletin (black dots, left-hand scale) and the fluorescent compound obtained from tobacco tissue (white dots, right-hand scale).

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References and Notes

1. K. Tryon, *Am. J. Botany* 42, 604 (1955).
2. Work conducted as a fellow of the American Cancer Society, recommended by the Committee on Growth of the National Research Council. I am indebted to F. Skoog, in whose laboratory the work was done.
3. R. H. Goodwin and F. Kavanagh, *Bull. Torrey Botan. Club* 76, 255 (1949).
4. Samples of scopoletin were kindly supplied by R. H. Goodwin, Connecticut College, and by W. A. Andreae, Science Service Laboratory, London, Ontario.
5. R. J. Best, *Australian J. Exptl. Biol. Med. Sci.* 22, 251 (1944).
6. R. H. Goodwin and B. M. Pollock, *Am. J. Botany* 41, 516 (1954).

26 September 1955

Book Reviews

The Fossil Evidence for Human Evolution. An introduction to the study of paleoanthropology. W. E. Le Gros Clark. University of Chicago Press, Chicago, 1955. x + 181 pp. Illus. $6.

This book is the first in a new series intended to provide "authoritative information about the growth and status" of various biological and medical subjects. It does this job admirably and will be important reading for specialists, students, and people interested primarily in other fields.

The author has not attempted to inventory the fossil record of the human family. In the first chapter he has chosen to underline some major problems of a morphological and phylogenetic nature important in analyzing and interpreting hominid evolution. He indicates the basic features that characterize the hominid and pongid radiations and the importance of defining clearly taxonomic categories on carefully chosen comparative-anatomical grounds. The need for an appreciation of modern evolutionary and genetic concepts is stressed and the significance of functional anatomical studies is indicated. The author emphasizes particularly the value of "total morphological pattern" (a term more inclusive than the "character complex" of the zoologist) in contrast to comparisons of isolated characters in assessing the status of a fossil.

The remainder of the book deals with the major taxonomic categories in the fossil record of the Hominidae. The author applies separate generic terms for the australopithecines of Africa and the Middle Pleistocene men of China and Java (*Australopithecus* and *Pithecanthropus*, respectively); all other fossil hominids are regarded as members of the genus *Homo*. The author's treatment proceeds from the present species (*Homo sapiens*) to that most recently extinct (*H. neanderthalensis*) and finally to the still earlier forms, *Pithecanthropus* and *Australopithecus*. After a discussion of the major morphological features of each, definitions are offered of each major category, and probable relationships are indicated. Although the book is well illustrated with line drawings, it is unfortunate that no photographs of fossil hominids are included.

There has long been a need for an up-to-date introduction to human evolution, particularly one that recognizes fully advances made in modern biology. Sir Wilfrid's book fills this void excellently. Undoubtedly many workers will quibble about minor points, but it remains nonetheless as a major effort by a worker well acquainted with the complexities of the field and the difficulties involved in providing final answers.

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Biochemistry of the Developing Nervous System. Proceedings of the first International Neurochemical Symposium, held at Magdalen College, Oxford, 13–17 July 1954. Heinrich Waelsch, Ed. Academic Press, New York, 1955. xvii + 537 pp. Illus. $11.50.

The rapid advance of biochemical techniques and knowledge in general has, during recent years, intensified research in brain and nerve chemistry. Investigators in a variety of border fields have become interested in this development. Organization of meetings on neurochemistry on an international scale appears therefore to be a useful effort. The book under review presents the proceedings of the first International Neurochemical Symposium. The conference was devoted to the "Biochemistry of the developing nervous system," but topics were discussed that covered a wide range of related fields: morphological and functional ontogeny of the central nervous system, chemical composition and intermediary metabolism of brain during growth, enzymes and enzyme inhibitors, genetic, hormonal, and pathological factors.

To illustrate the diversity of the specific subjects reviewed, a few of them may be mentioned. V. Hamburger discussed "Trends in experimental neuroembryology"; J. Folch-Pi, "Composition of the brain in relation to maturation"; W. M. Sperry, "The lipids of the brain during early development in the rat"; D. Richter, "Metabolism of the developing brain"; H. Waelsch, "Blood-brain barrier"; L. B. Flexner, "Enzymatic and functional patterns of the developing mammalian brain." The pathological chemistry of the developing brain was reviewed by E. Klenk; "Genetic factors of the development of the nervous system" by S. Gluecksohn-Waelsch. Remarkable developments in ultramicro techniques were presented by Lowry and Hyden; the former showed well reproducible data on enzyme activity with 0.1 microgram of tissue or less; the latter described a new method of x-ray microphotometry, which permits in the analysis of nerve cells the determination of the intracellular mass, lipids, and proteins, in amounts of picograms (10^{-12} g).

It is impossible to mention all the interesting papers presented. Some of them, as might be expected among such a great number of papers, did not stand up to the high level maintained in general, but the few examples noted here may suffice to show the broad approach that was applied. The rapid scientific developments in so many directions make it difficult for the investigator to follow neighboring fields of interest in his work, and it should be one of the functions of such symposia to serve as a means of communication. Although the book contains much valuable information, the discussion of the innumerable gaps in our knowledge of the various fields is perhaps as profitable as the presentation of the progress achieved.

The question may be raised whether it is worth while to include in the book all the discussions. Many remarks, even if appropriate at the meeting, do not really contribute to the information of the reader. On the other hand, they increase the editorial burden, probably out of proportion to their significance, raise the costs, and impose unnecessarily on the time of the reader. A procedure may be found to include only those discussion remarks that contain pertinent criticism or additional information of real value. On the whole, the book is to be recommended as a collection of interesting and stimulating papers that convey a fair picture of the present state of the subject to all those interested in the field.

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Small-Angle Scattering of X-rays. André Guinier and Gérard Fournet. Translated by Christopher B. Walker. Wiley, New York; Chapman & Hall, London, 1955. xi + 268 pp. Illus. $7.50.

Small-angle scattering of x-rays was first used in 1930 to study particle size. In the 25 years that have elapsed, especially in the last 10, the study of such scattering has become of very great importance, particularly because of its application to the

elucidation of pressing technologic problems. The subject is not an easy one. In many papers that have appeared, particularly those devoted to theory, the treatment has been such as to muddy the waters rather than to clarify them. This timely and elegantly written monograph succinctly brings the reader up to date. The authors have, with expertness, separated the grain from the chaff.

The first four chapters, entitled "Origin and characteristics of small-angle x-ray scattering," "General theory," "Experimental equipment," and "Methods of interpretation of experimental results," cover these subjects clearly, thoroughly, and, above all, thoughtfully. The final two chapters deal with the results achieved to date and will prove a surprise to many scientific workers, who will discover that here is a versatile physical technique, useful in such diverse fields as metallurgy, biology, and mineralogy, which they have perhaps overlooked. The metallurgist will discover that small-angle x-ray scattering studies of severely cold-worked metals tell him some of the story of what happens during cold-working, and the biologist will find that the sizes and shapes of protein and virus molecules can be obtained from the interpretation of small-angle data.

A bibliography, originally compiled by K. L. Yudowitch and expanded somewhat to include recent work, follows the text. It lists 569 papers. Here, a perhaps petty criticism can be made. It is too complete; some papers are listed that do not deal with the subject even remotely.

To anyone interested in small-angle scattering this book is a "must." The volume may perhaps be disconcerting to those who have worked in this field, for it will also tell most of us where we have erred!

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Echinodermata. vol. IV of *The Invertebrates.* The coelomate bilateria. Libbie Henrietta Hyman. McGraw-Hill, New York, 1955. vii + 763 pp. Illus. $10.

One must sincerely regret that the four outstanding echinodermologists to whom Libbie Hyman pays homage in her introduction did not live to see this volume published. These men who spent 40 to 60 years of their lives on the study of echinoderms would, more than any other reader, have been able to appreciate the gigantic work that the author has completed. To be acquainted with the enormous amount of literature is in itself an accomplishment, especially for a nonspecialist, and to weld the whole subject together into a complete and harmonious picture is more than what one could expect a single individual to do.

The volume consists of a single chapter, divided into 12 parts. After a brief outline of the history of the phylum and its most salient features, the reader is given a bird's-eye view of the classification, and then the different classes are treated in detail. The arrangement of each section is similar to that used in the earlier volumes of the series, and in other works of similar scope. Considerable space is given to the distribution, since the echinoderms are well suited to delimit marine geographic provinces.

Much of the account follows the classical pattern, laid down in the large works published in Europe around the turn of the century, and here brought up to date with the inclusion of the many important contributions that have been made since that time. Of particular interest is the part that deals with these animals' physiology, which was almost unknown 50 years ago.

The last section deals with the phylogeny of the echinoderms and justifies the unorthodox manner in which the author has rearranged the various classes. Based as it is, on larval forms, it is an arrangement that most students of these animals have visualized, without having taken any further step in that direction.. The views of the author are well supported by the most recent biochemical studies. The account is fascinatingly written and is convincing, although the author probably will agree, in the case of these unpredictable animals, that one can modify Miss Hawes' opinion on fashion and say that phylogeny is spinach.

The style is easy flowing and clear; the language is refreshingly unorthodox and picturesque, although the author never forgets to brief the reader on the peculiar language of the specialists, without which they would not be able to delve into the original papers. The typographic setup is of the same quality as in the previous volumes; typographic errors are rare and quite unimportant, and there are few statements that need to be corrected.

The illustrations complete the text and appear whenever they are needed. Many are original, while others have been redrawn by the author, which also adds to the harmonious aspect of the volume. The numbering is clear, the legends are models of clearness, and, characteristic of the author's ability to omit irrelevant matters, all measurements are consistently left out where they are not needed. The method of giving the reference to a special question in the text as is done here is infinitely to be preferred to the nondescript numbers used in similar works. It takes a little more space, but it fixes the author's name in the reader's mind in connection with this particular problem. If the reader wishes to check on such a point, he turns to the end of the volume, where 40 pages of literature are printed with a compactness reminiscent of a New York subway during rush hours, but where one with the greatest ease can extract complete information about each paper.

The obvious enjoyment the author has had in tackling this odd group of animals and overcoming all obstacles seems to penetrate the whole work. It comes out in the open in the preface, where the echinoderms are saluted as a noble group of animals. After one has had the pleasure of reading this volume, one is happy to salute the noble work of a noble writer.

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The Atomic Nucleus. Robley D. Evans. McGraw-Hill, New York, 1955. xv + 972 pp. Illus. $14.50.

This book has been two decades in the making: it is the result of 20 eventful years' experience in teaching a course in the rapidly changing subject of nuclear physics to seniors and first-year graduate students at Massachusetts Institute of Technology. It could not have been written so well by anyone without such experience, and both today's student and instructor are very much in Robley Evans' debt for making their respective tasks so much easier.

Although I have not had the good fortune of having been a member of one of Evans' classes, I did meet the present book as an old friend after a lapse of years, for in common with many others on this continent I used, in the early 1940's, the mimeographed versions of Evans' class notes as very welcome material for my own first attempts at teaching a similar course, now taken over by a colleague. As often happens on meeting old friends after an interval of a decade or more, one is struck by an increase not only in their experience of the world and in their wisdom but, alas, also in their girth. In this case the "girth" is partly unavoidably due to the growth of the subject, but to some extent the usual explanation of obesity—too catholic an appetite—also applies here. Of the book's 972 pages, 566 are devoted to a discussion of the nucleus (with time out at several points for what amounts to a short course on wave mechanics supplemented later by an additional 38-page mathematical appendix). Of the balance, 179 pages deal with the interactions between particles, radiation, and matter, and 63 with a condensed course on sta-

tistics. More appendixes, an extensive index, and a really first-rate 33-page bibliography (up to date to 1954) with nearly 1100 entries occupy the rest of the book. The book is well cross-indexed.

The 17 chapters on the nucleus are divided into nine on properties of nuclei (Z, R, M, moments, parity, statistics, isotopic abundance, binding energy, and nuclear systematics), five on nuclear forces, models, and reactions, and three on α and β decay. However, the static and dynamic properties of nuclei are not separated into watertight compartments, for a very pleasant feature of the book is the arrangement of the sequence of topics dictated by the author's pedagogic experience in accordance with the principles of "minimum regret" and "varied reiteration" enunciated in the preface.

The book is written from the point of view of an experimental physicist, but it includes good summaries of the principal theoretical results required to interpret the experimental data. A feeling for the historical development has been successfully cultivated.

All in all this is probably the best reference textbook of its kind available on the subject today.

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Traité de Paléontologie. vol. V, *Amphibiens, Reptiles, Oiseaux.* La sortie des eaux, naissance de la tétrapodie, l'exubérance de la vie vegetative, la conquête de l'air. Masson, Paris, 1955. 1113 pp. Illus. F. 12,800.

The *Traité de Paléontologie,* now being published in Paris under the direction of Jean Piveteau as a series of seven large volumes, is a truly monumental work that will present, when it is completed, a comprehensive survey of the animal life of the past. Volume V of the series deals with the amphibians, most of the reptiles, and the birds. An impressive array of European paleontologists contribute to this volume—namely, Piveteau, Jarvik, Dechaseaux, Lehman, Nielsen, Saint-Seine, Peyer, Kuhn-Schnyder, Bergounioux, Hoffstetter, Kälin, de Lapparent, and Lavocat. The result is an authoritative, handsome, and well-illustrated book.

The work is more than a routine compendium of our present knowledge about amphibians, reptiles, and birds of past ages; volume V of the *Traité* is a well-written and carefully integrated text, in which the various groups of "lower" tetrapods are described and discussed from different points of view. Although the general organization of the work is necessarily systematic, which means that the orders and lesser taxonomic divisions of these vertebrates, down to significant genera, are considered in their proper sequence and relationships, the particular value of the work is in the many discussions of general and special adaptations, evolutionary trends, classification, environmental and ecological factors, and many other topics. All this makes for an extraordinarily useful and readable volume, of inestimable value to the paleontologist and zoologist.

It is impossible here to attempt any remarks in detail on a book as large and as extensive in subject matter as this one. Perhaps it is enough to say that the volume can be used with a feeling of confidence, for the text represents the best judgment of outstanding experts in their several fields and has been prepared with attention to the accuracy of details as well as to the interest of its more general discussions. The omission of the synapsid reptiles from the volume (presumably they will be included in volume VI of the series) will be regretted by many who would find it logical and helpful to have all of the reptiles together in one book. But there is compensation for this omission by reason of the full treatment given to all of the other lower tetrapods. Errors are too trifling to deserve mention here. Indeed, Piveteau and his colleagues are to be congratulated on a major achievement.

It is unfortunate that the book is so very expensive; the price will keep many students who ought to have it from purchasing it.

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New Books

The Meaning of Relativity. Albert Einstein. Princeton University Press, Princeton, N.J., ed. 5, 1955. 166 pp. $3.75.

Language, Thought, and Reality. Selected writings of Benjamin Lee Whorf. John B. Carroll, Ed. Technology Press, Massachusetts Institute of Technology, Cambridge, Mass.; Wiley, New York; and Chapman & Hall, London, 1956. 278 pp. $7.

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Scientific Meetings

Nuclear Engineering and Science Congress

Atomic energy has become a multidimensional phenomenon with many ramifications into the social, as well as into the natural and engineering, sciences. It still has a fantastically destructive potential, but this is now being strongly offset by its positive and beneficial effects in many different areas. Not only are we building a complex technology with a variety of "peaceful applications," but at the same time atomic energy has become a force to pull groups together with diverse interests.

People with widely varying specialties and with different backgrounds of experience are finding that they must work together if the problems are to be solved. The barriers that so frequently tend to develop between different disciplines are in this instance being weakened, with increased mutual understanding as the result. For example, power-reactor development cannot be successful without the joint cooperation of science and engineering; of government, industry, and education; of insurance companies and power companies; and of the United States and other countries on this side of the Iron Curtain and maybe—in the end—on the other side as well.

Under the shadow of an atomic-weapons race between the United States and the U.S.S.R., enthusiasm for the development of peaceful atomic applications has grown in chain-reaction fashion during the last year or so. One might say that the control rods on this reaction were pulled back at Geneva, and the activity throughout the world since then is proceeding so fast that it is very difficult to keep track of it and to see what patterns are forming.

It was against this background that the Nuclear Science and Engineering Congress was held at Cleveland, Ohio, during the week of 12 Dec. Twenty-six different organizations came together to discuss some of their mutual interests and activities in the atomic-energy field. The proceedings were planned by a general committee formed from the sponsoring societies as a result of initiative taken by the Engineers Joint Council. Under the chairmanship of John R. Dunning (Columbia University), this committee established subcommittees that managed to put together a successful and fast-moving program.

The significance of the meeting lay in its broad sponsorship and in the variety of subjects that came up for discussion under the general heading of nuclear science and engineering. To provide a rough picture of the total proceedings, and to illustrate the diversity of interests that found common ground, the societies that contributed papers are listed here, along with examples of subjects discussed in each case. More than half of the papers were provided by eight of the ten constituent societies of the Engineers Joint Council, and these societies are therefore listed first.

American Institute of Chemical Engineers: "Reactor-site selection," "The reactor at the University of Michigan," "Gamma-radiation effects on certain solutions," "Sodium cooling of reactors," "Uranium diffusion through graphite," "Continuous dissolution of uranium reactor fuels," "Small nuclear power packages," "Storage tanks for radioactive wastes," "Neutron flux measurements."

This organization was particularly active, not only in terms of the number of papers presented, but also in its sponsorship of an International Atomic Exposition, which was held simultaneously, and in its arrangements for the sale to those interested of preprints of most of the papers. At a special dinner meeting, the speaker was Gunnar Randers, special adviser on atomic energy matters to the Secretary-General of the United Nations. He gave an excellent presentation of his country's view of the cooperation on atomic matters showing that small size states such as his need to get into commercial operation in order to raise their standard of living.

American Society of Mechanical Engineers: "The liquid metal fuel reactor," "Reactor pressure vessels," "Reactor safety and shielding," "Reactor controls and instrumentation," "Fuel elements," "The corrosion of liquid metal coolants," "Temperature transients in a nuclear power system."

American Institute of Mining and Metallurgical Engineers: "Radiation damage to metals," "Neutron effects in graphite," "Solid hydrides," "Ceramic fuel materials," "Production of uranium metal," "Zirconium metallurgy."

American Water Works Association: "Measurement of radioactivity in water," "Radiochemical techniques for radioisotope separation," "Removal of radiation fallout by water treatment processes," "Land disposal of reactor wastes."

American Institute of Electrical Engineers: "Control of research-type nuclear reactors," "Reactor instrumentation at Chalk River," "Dynamics and control of nuclear power plants," "A reactor simulator for teaching purposes," "Machine sources of ionizing energy."

American Society for Engineering Education: In order to illustrate the kinds of educational backgrounds that are important in nuclear engineering, the views of specialists in five different areas were presented: "Nuclear and thermal design of power reactors," "Mechanical design of power reactors," "Fuel element, metallurgy, corrosion, and coolant problems," "Reactor control and instrumentation," "Design of radioactivity facilities and absorption shields." The speakers were generally agreed that in the training of nuclear engineers emphasis should be placed first upon the engineering fundamentals, but that the standard courses can be enriched by including problems and examples from the nuclear field.

American Society of Civil Engineers: "Meteorology as related to reactor-site selection," "Radiation effects on structural materials," "The Army package power reactor."

American Society of Refrigerating Engineers: "High radio pasteurization—a new process of food preservation combining radiation with refrigeration."

American Chemical Society: "Literature on nuclear engineering, radiation hazards, biological effects of radiation, and so forth," "Radioisotopes in chemical studies," "Boron compounds," "Neutron reactions in chemical analysis," "Radiation-induced cross-linking and degradation," "Radiation effects on polymers," "Legal problems in atomic energy," "U^{233} and thorium separation from fission products," "New developments in high-temperature emf measurements," "Water quality problems," "Hot laboratory preparations at kilocurie level," "Atomic waste disposal," "Radioactivity in stream pollution," "Plutonium hexafluoride." The ACS contributed more papers than any other single society, and since the AIChE contributed nearly as many, it can be said that the meeting was largely chemical in character. Together these two organizations contributed more than a third of the papers.

American Nuclear Society: "Irradiation effects in uranium and its alloys," "Fluid breeder reactor concept," "Evo-

lution of gas from graphite-moderated material," "The small liquid metal fuel reactor," "Temperature-dependent kinetics of circulating fuel reactors," "Design of radiation analytic facilities," "Testing of reactor fuel elements," "Economics of radiochemical plants," "Neutron cross sections of plutonium isotopes," "Nuclear properties of U^{233} and U^{235}." The existence of this society is in itself a recognition of the fact that atomic energy will not fall within the sphere of any one of the older societies. It was organized to provide a common meeting ground for physicists, chemists, biologists, and all others with a special interest in nuclear science.

American Geological Institute: "Radioactivity surveying," "Uranium supplies," "Uranium deposits in different parts of the world," "Uranium processing and geochemistry."

American Society for Metals, American Society for Testing Materials, Institute of Radio Engineers, Society of Automotive Engineers, and American Rocket Society: "Hydrogen-uranium relationships," "Self-luminous materials," "An accelerator as a radiation source," "Radioactive methods for measuring engine deposits," "Nuclear radiation in combustion research."

Atomic Industrial Forum: "AEC licensing policies and procedures," "The insurance problem," "Radiation safety regulations," "AEC classification policies," "Atomic energy patent problems." This organization represents a large variety of industrial interests in atomic energy, thus broadening even more the base of the meeting.

Cleveland Engineering Society: This organization sponsored a well-attended 1-day conference for management on "The place of the atom in your business."

To summarize the meeting in terms of society participation does not give a fair picture, because, after all, the program was organized into 50 separate sessions with several societies contributing to each in most cases. Many of the titles of these sessions related, of course, to reactor technology. The liquid metal fuel reactor attracted the most attention of the various reactor types that were considered. With uranium carried in solution or as a slurry in liquid bismuth at high temperatures, this system appears to have some real advantages, but the attention given to it at Cleveland is probably out of proportion to its present state of development.

Also of special interest was a reactor design concept presented by H. H. Hyman and J. J. Katz (Argonne National Laboratory). They propose a heterogeneous reactor that permits continuous chemical processing of the fuel. In heterogeneous systems, it is ordinarily necessary that the fuel elements be removed from time to time for separate processing, whereas continuous chemical treatment of the fuel is one of the big advantages of a homogeneous reactor system. In this instance, the virtues of the two systems are combined by using bare uranium fuel elements, which are slowly dissolved in the cooling fluid, which is continuously processed.

The complicated question of separating uranium and plutonium from fission products was discussed in some detail by both the chemists and the chemical engineers. Other sessions were devoted to the effects of radiation on structural materials, on chemical reactions, on polymers, and on food. These radiation effects promise to open up new fields in the chemical and food and drug industries. Much is still to be learned, but whereas we used to speak of "radiation damage," it is now becoming customary to refer to "radiation effects."

Safety problems, site selection, and the disposal of reactor wastes occupied several sessions. Uranium deposits in several different parts of the world were discussed, along with the pertinent geology and methods of surveying.

One of the major problems in the design of reactor fuel elements results from the effects of radiation on the uranium itself. For some reason, the uranium changes its dimensions, and to prevent this becomes a major metallurgical problem. In discussing these effects in a paper entitled "Irradiation effects in uranium and its alloys," S. H. Paine and J. H. Kittel made an interesting observation. They concluded "candidly" that uranium "is not a very satisfactory engineering material for use in a nuclear reactor." They were, however, willing to admit that its one "virtue is that it fissions."

The meeting also had its political overtones. Senator Clinton P. Anderson, chairman of the Joint Congressional Committee on Atomic Energy, was the after-dinner speaker at the Cleveland Engineering Society's Conference for Management. Senator Anderson attracted considerable attention by attacking the secrecy policies of the Atomic Energy Commission and its policies related to access permits. By the end of the year, the AEC had awarded permits to more than 600 different organizations, each with permission to acquire certain kinds of classified information. Senator Anderson had this to say: "Why did we ever need access permits and clearances? Here [in Cleveland] are businessmen and scientists from all over the world talking about so-called secrets! But 10,000 people at home have been reading confidential material as I have. How long do they stay secrets? . . . Now exactly what do we accomplish by this procedure? I will pass over the question of whether such confidential information is worth guarding. I will ask instead if this whole complicated system of clearances keeps information out of the hands of our enemies—assuming they want it. Of course it doesn't. Are we to think that a foreign spy would necessarily have some sort of a police record showing him to have been an undesirable citizen or an embezzler when he asks an "L" clearance check? Hardly! . . ."

At the All-Congress dinner Lewis L. Strauss, chairman of the Atomic Energy Commission, was the speaker. He emphasized the seriousness of a "mounting shortage" of scientific and engineering talent. He said that, unless we create a large reservoir of technical talent and make certain that the reservoir is consistently replenished, we will be outdistanced and left behind. He pointed out that this country is at present training fewer than 500 persons a year for work in the field of atomic power, whereas there is a current need for 3 or 4 times this number. He took this occasion to announce that to help meet this problem a summer institute for engineering college professors is to be held at Argonne during an 8-week period this coming summer. It is to be jointly sponsored by the AEC, National Science Foundation, the American Society for Engineering Education, and Northwestern University. The purpose is to help engineering college professors gain a more intimate acquaintance with the field in order that they may include nuclear materials in their engineering courses.

The story of the meeting cannot be complete without reference to the 161 exhibitors of the International Atomic Exposition. Many of the organizations represented reported enthusiastically both on sales orders and on new contacts. Most of the exhibitors were industrial and in many cases repeated what was shown at Geneva last August. Of special interest was the subcritical nuclear reactor in actual operation that was shown by New York University. The American Museum of Atomic Energy had a wide variety of educational exhibits illustrating the peacetime uses of atomic energy. The exhibit of the Quartermaster Food and Container Institute for the Armed Forces was of special importance, because it illustrated the possible use of radiation for food sterilization.

It is the purpose of this summary to give some picture of the over-all proceedings as planned by the program committee, but the meeting had, without doubt, another large impact, which cannot be summarized. The informal discussions that took place in the Exhibit Hall, in the corridors, and in the hotel rooms provided many opportunities for exchange of views, discussion of common problems, and, without doubt, for job seeking and recruitment. The informal

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To a certain national wildflower society, however, which does have a beautiful color transparency of *Castilleja linearifolia* to reproduce in its bulletin, this order of expenditure is enough to chew its whole publication budget into shreds. Such figures have scared off many other societies and publishers of periodicals and books aimed at smallish audiences.

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But, by George, it's color printing, and it might be just the ticket for the scientist with a few Kodachrome or Ektachrome slides that drive home the whole point he wants to make. Matter of fact, it was him we developed the process for.

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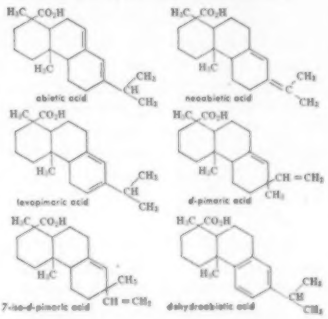
When the bark of a longleaf pine is scraped down into the sapwood, the wound exudes an item of commerce called gum oleoresin. This consists of a mixture of α- and β-pinenes, sold as gum turpentine, plus a mixture of the following resin acids:



Dancing to the tune of temperature and pH, the loose protons and the double-bond electron configurations can twinkle around in these isomers like so many animated electric signs. If you do your work in the cold, you'll find that levopimaric acid is the largest single component of these resin acids; it is particularly dominant in early spring sap.

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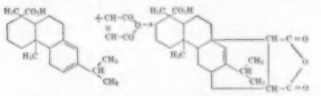
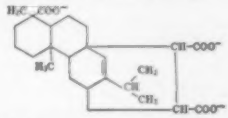


With the aid of a little sodium hydroxide, this can pick itself up a solvating charge at three places and go floating off to new adventures with all that molecular weight, water-soluble as you please.



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breakfast meetings that were organized to bring together those on the same programs provided many opportunities for people to associate faces with names they already knew. Also, it was significant that a number of representatives of German industry were much in evidence.

A meeting of this kind was without precedent, but it was clearly a success. With atomic energy continuing to draw more groups together and, at the same time, leading in new directions, there can be little doubt that the forces that brought this meeting into being will in due course operate to produce another.

PHILIP N. POWERS
Internuclear Company, Clayton, Missouri

Meeting Notes

■ Supported by the Sociedade Brasileira para o Progresso da Ciência (Brazilian Society for the Advancement of Science), the National Research Council of Brazil, and the Associação Paulista de Bibliotecários (Paulista Association of Librarians), a symposium on scientific bibliography and documentation was held in São Paulo 24–27 Feb. The program of the symposium included (i) bibliographic problems that scientists and librarians are interested in, (ii) the Brazilian Institute of Bibliography and Documentation, (iii) systematic documentation, (iv) photographic documentation, (v) the most important bibliographic problems in Brazil.

There were also panels on librarianship; punch-card bibliographic method; union catalogs of books and periodicals; bibliographic research on social sciences, physics, and natural history; and the meaning of documentation.

This symposium was organized by the Sociedade Brasileira para o Progresso da Ciência in connection with many other Brazilian university libraries under the responsibility of Paulo Sawaya, general secretary of the SBPC, P.O. Box 2926, São Paulo, Brazil.

■ The American Electroencephalographic Society will hold its tenth annual meeting at the Claridge Hotel, Atlantic City, N.J., 15–17 June. The program includes a colloquium on "The history of neurophysiology," with Alexander Forbes as chairman, and a symposium on "EEG in the diagnosis of coma states," with Jerome K. Merlis as chairman.

■ The ninth annual summer conference sponsored by the biology department of Brookhaven National Laboratory will be held 21–23 May, 1956. The program consists of a symposium on Genetics in Plant Breeding. The program is divided into five sections as follows.

"Use of changes in the chromosomal complement," K. Sax, E. R. Sears, E. G. Anderson, and G. L. Stebbins; "Applications of the studies in quantitative inheritance," E. R. Dempster, C. C. Cockerham, and R. Allard; "Use of self-incompatibility and male sterility," M. M. Rhoades, D. Lewis, D. F. Jones, and W. H. Gabelman; "Use of radiation-induced mutations," W. M. Myers, J. MacKey, C. F. Konzak, and W. C. Gregory; "Use of natural and induced variability," R. A. Brink, J. D. Harlan, G. W. Keitt, and D. M. Boone.

The conference will be held at the laboratory, which is located at Upton, Long Island, about 65 miles east of New York. Inquiries about further information should be addressed to Dr. H. H. Smith, Brookhaven National Laboratory, Upton, N.Y., *by 1 May*.

■ The 32nd annual meeting and 29th annual scientific sessions of the American Heart Association will be held in Cincinnati, Ohio, beginning 27 Oct. and continuing through 31 Oct. The scientific portion of the meeting will be conducted 27–29 Oct. Those wishing to present papers must submit abstracts *by 15 May* to the Medical Director, American Heart Association, 44 E. 23 St., New York.

Because of the expanded facilities available, there will be space for an increased number of both scientific and technical exhibits. Application forms for prospective scientific exhibitors must also be submitted to the medical director *by 15 May*.

■ The fifth National Clay Conference will be held at the University of Illinois, Urbana, 8–10 Oct. The conference is sponsored annually by the Clay Minerals Committee of the National Academy of Sciences–National Research Council, under the chairmanship of R. E. Grim of the University of Illinois.

Contributed papers on subjects related to clay mineralogy or technology will be welcome. Titles for inclusion in the program must be received *by 1 May*, and short informative abstracts will be required *by 15 June*. Titles and abstracts may be sent to Dr. W. F. Bradley, Illinois State Geological Survey, Urbana.

■ The American College of Cardiology will hold its fifth annual convention at the Hotel Drake in Chicago 16–18 May. The meeting over which Walter S. Priest of Chicago will preside, will present three symposia devoted to (i) congestive heart failure, (ii) cor pulmonale, and (iii) cardiac catheterization and angiocardiography. The sessions will cover all aspects of research, diagnosis, and therapy.

In addition, there will be research and commercial exhibits outlining the latest advances in cardiology. Further information may be obtained from the secretary of the college, Dr. Philip Reichert, Empire State Building, New York, N.Y.

■ The Atomic Industrial Forum has announced that site of the second annual Trade Fair of the Atomic Industry has been shifted from the Morrison Hotel in Chicago to the Navy Pier. The fair will run during the period 24–28 Sept., concurrently with a major forum meeting on "Management and technology for the atomic industry," 25–27 Sept. The Morrison Hotel will remain as conference headquarters and primary meeting location.

Emphasis in the Trade Fair is on the products and services directly related to the application of atomic energy, either through power generation, heat utilization, or wide use of radiation in manufacturing processes, research, agriculture, medicine, and food sterilization.

■ The third International Conference on Biochemical Problems of Lipids will be held in Brussels, Belgium, 26–28 July and will consider the blood lipids and the clearing factor. Topics to be discussed are the chemical and physical-chemical properties of the blood lipids and lipoproteins, the changes in lipid distribution, the mechanism of clearing and the enzymatic factors involved, the relationship to metabolism, transport, and other related problems.

The conference is organized under the auspices of the Royal Flemish Academy of Sciences of Belgium in the "Paleis der Academien," Brussels. Inquiries and applications for participation should be addressed to the chairman of the organizing committee, Prof. R. Ruyssen, St. Jansvest 12, University of Ghent, Ghent, Belgium.

■ The annual meeting of the Society of Rheology was held in New York City, 2–4 Nov. 1955. Herbert Leaderman (National Bureau of Standards) was presented with the Bingham medal of the society by John D. Ferry (of the University of Wisconsin). Ferry reviewed Leaderman's researches and writings in the field of rheology and pointed out the importance of his work in preparing and promoting an international standard of nomenclature for the science of flow and deformation of materials.

The technical program of the meeting was divided into five half-day sessions. At the first session on Wednesday afternoon, four papers dealing with the rheology of metals were presented. During succeeding sessions, papers were given on such diverse topics as the deformation of the earth, the flow of glacier ice, the

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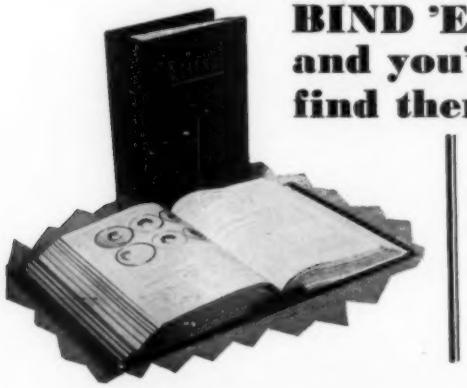

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relationship of the flow of synovial fluid to health and disease in the human body, and mathematical approaches to rheological problems. Several papers described the visco-elastic properties of various high-polymeric materials used for rubbers, plastics, and fibers. A new kind of mass flowmeter was described, and methods for making improved measurements of bulk moduli and intrinsic viscosities were considered.

■ The 36th annual meeting of the American Society of Ichthyologists and Herpetologists will be held at the Conservation Training School, Higgins Lake, near Roscommon, Mich. 21–24 June. Housing accommodations for adults may be arranged by addressing the school. Titles of papers to be presented should reach Charles F. Walker, Museum of Zoology, Ann Arbor, Mich., *by 1 May*. Inquiries may be directed to the local chairman, Dr. Reeve M. Bailey, Museum of Zoology, Ann Arbor.

Society Elections

■ American Association of Scientific Workers: pres., Harry Grundfest, Columbia University; sec., Robert Rutman, National Secretary, 6331 Ross St., Philadelphia, Pa.; treas., Alfred Lisi, Philadelphia, Pa. The vice presidents are Hans Blumenfeld, Kirtley Mather, Dwight McNair-Scott, Phillip Newmark, Linus Pauling, Melba Phillips, Theodor Rosebury, and Leland Taylor.

■ Association for Applied Solar Energy: pres., Jan Oostermeyer, Phoenix, Ariz.; vice pres., Walter T. Lucking, Arizona Public Service Company, Phoenix; sec.-treas., John I. Yellott, Stanford Research Institute, Menlo Park, Calif.

■ Council of the American Association of Physics Teachers: pres., Walter C. Michels, Bryn Mawr College; pres. elect, Vernet E. Eaton, Wesleyan University; Frank Verbrugge, Carleton College; treas., Francis W. Sears, Dartmouth College.

■ Genetics Society of Canada: pres., Stanley G. Smith, Forest Insect Laboratory, Sault Ste. Marie, Ontario; v. pres., T. J. Arnason, University of Saskatchewan; sec.-treas., J. W. Morrison, Cereal Crops Division, Central Experimental Farm, Ottawa, Ontario.

■ Society of Rheology: pres., F. D. Dexter, Bakelite Company; 1st v. pres., J. H. Dillon, Textile Research Institute; 2nd v. pres., J. H. Elliott, Hercules Powder Company; editor, Bryce Maxwell, Princeton University; sec.-treas., W. R. Willets, Titanium Pigment Corporation.

Forthcoming Events

May

1–3. Electronic Components Symposium, 7th annual, Washington, D.C. (A. W. Rogers, U.S. Army Signal Corps, Fort Monmouth, N.J.)

3–5. American Philosophical Assoc., Western Div., Bloomington, Ind. (W. H. Hay, Bascom Hall, Univ. of Wisconsin, Madison 6.)

3–5. Illinois State Acad. of Science, annual, Springfield, Ill. (L. E. Bamber, 223 Natural History, Univ. of Illinois, Urbana.)

3–5. Midwestern Psychological Assoc., annual, St. Louis, Mo. (D. W. Fiske, Dept. of Psychology, Univ. of Chicago, Chicago 37, Ill.)

3–5. Soc. for American Archaeology, annual, Lincoln, Nebr. (A. C. Spaulding, Museum of Anthropology, Univ. of Michigan, Ann Arbor.)

4. American Assoc. of Spectrographers, 7th annual, Chicago, Ill. (J. P. Merutka, H. M. Harper Co., 8200 Lehigh Ave., Morton Grove, Ill.)

4. Annual Conf. for Engineers, Columbus, Ohio. (H. A. Bolz, College of Engineering, Ohio State Univ., Columbus 10.)

4–5. Chi Beta Phi National Convention, Charleston, W.Va. (C. B. Park, Dept. of Chemistry, Lenoir-Rhyne College, Hickory, N.C.)

4–5. Minnesota Acad. of Science, annual, Minneapolis. (B. O. Krogstad, Science and Mathematics Div., Univ. of Minnesota, Duluth Branch, Duluth 5.)

4–5. Wisconsin Acad. of Sciences, Arts, and Letters, annual, Milwaukee. (R. J. Dicke, 3 King Hall, Univ. of Wisconsin, Madison 6.)

4–6. Oklahoma Acad. of Science, Quartz Mountain State Park. (D. E. Howell, Entomology Dept., Oklahoma A. & M. College, Stillwater.)

6–9. American Inst. of Chemical Engineers, New Orleans, La. (F. J. Van Antwerpen, AIChE, 25 W. 45 St., New York 36.)

7–8. New Orleans Acad. of Science, annual, New Orleans, La. (Father J. H. Mullahy, S.J., Dept. of Biological Sciences, Loyola Univ., New Orleans 18.)

8–10. Symposium on Chemistry and Biology of Purines, London, England (invitational). (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Pl., London, W.1.)

9. American Acad. of Arts and Sciences, annual, Cambridge, Mass. (R. W. Burhoe, 28 Newbury St., Boston 16, Mass.)

9–12. Virginia Acad. of Science, annual, Richmond, Va. (F. F. Smith, Box 1420, Richmond 11.)

10. Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawes Products, 4800 S. Richmond, Chicago 32.)

10–11. American Inst. of Chemists, annual, Boston, Mass. (L. Van Doren, AIC, 60 E. 42 St., New York 17.)

10–11. Atomic Energy Conf., San Antonio, Tex. (E. Wiggin, Atomic Industrial Forum, Inc., 260 Madison Ave., New York 16.)

10–11. Operations Research Soc. of America, 4th annual, Washington, D.C. (H. J. Miser, Rt. 2, Box 211, Vienna, Va.)

10–12. National Science Fair, 7th annual, Oklahoma City, Okla. (J. H. Kraus, Science Clubs of America, 1719 N St., NW, Washington 6.)

11–12. Indiana Acad. of Science, Martinsville. (W. A. Daily, Eli Lilly Research Laboratories, Indianapolis 6, Ind.)

14–15. Soc. of American Military Engineers, 36th annual, Washington, D.C. (SAME, 808 Mills Bldg., Washington 6.)

14–17. Symposium & Exhibit on Recent Developments in Research Methods and Instrumentation, 6th annual, Bethesda, Md. (J. B. Davis, National Institutes of Health, Bethesda 14.)

14–19. Assoc. of Official Seed Analysts, Sacramento, Calif. (R. G. Colborn, Seed Div., Dept. of Agriculture, Capitol Bldg., Lincoln, Nebr.)

14–19. International Spectroscopical Colloquium, 6th, Amsterdam. (F. Freese, Laboratorium voor Analytische Chemie, 125 Nieuwe Achtergracht, Amsterdam.)

15–16. Industrial Nuclear Technology Conf., Chicago, Ill. (INT Conf., Armour Research Foundation, 10 W. 35 St., Chicago 16.)

16–18. American College of Cardiology, 5th annual, Chicago, Ill. (P. Reichert, Empire State Bldg., New York, N.Y.)

16–18. Soc. for Experimental Stress Analysis, Pittsburgh, Pa. (W. M. Murray, Massachusetts Inst. of Technology, Cambridge 39.)

17. Maryland Acad. of Science, annual, Baltimore. (T. King, MAS, Enoch Pratt Free Library, Baltimore 1.)

18–26. World Cong. on Fertility and Sterility, 2nd, Naples, Italy. (C. D. Guerrero, Melchor Ocampo 487, Mexico, D.F. Mexico.)

19–20. Population Assoc. of America, annual, Ann Arbor, Mich. (H. Carter, National Office of Vital Statistics, Public Health Service, Washington 25.)

20–22. Building Research Inst., 5th annual, Niagara Falls, Ontario, Canada. (W. H. Scheick, BRI, 2101 Constitution Ave., Washington 25.)

20–22. International Cong. of Neo-Hippocratic Medicine, Montecatini Terme, Italy. (Dr. Valente, 41 Av. Verdi, Montecatini, Terme.)

20–24. American Assoc. of Cereal Chemists, New York, N.Y. (C. L. Brooke, Merck & Co., Inc., Rahway, N.J.)

21–23. American Trudeau Soc., 51st annual, New York, N.Y. (Miss E. Lovell, National Tuberculosis Assoc., 1790 Broadway, New York 19.)

21–24. Air Pollution Control Assoc., Niagara Frontier, annual, Buffalo, N.Y. (H. C. Ballman, APCA, 4400 Fifth Ave., Pittsburgh 13, Pa.)

23–1. International Cong. of Animal Reproduction, 7th, Madrid, Spain. (European Assoc. for Animal Reproduction, Via Quintino Sella 54, Rome, Italy.)

23–26. European Symposium on Vitamin B_{12}, 1st, Hamburg, Germany. (H. Bauer, Nervenklinik, Hamburg-Eppendorf.)

24–26. International Cong. on Pathology of Infectious Diseases, Lyons, France. (Secretary, Institut Pasteur, Paris.)

24–26. National Soc. of Professional Engineers, Atlantic City, N.J. (P. H. Robbins, 1121 15 St., N.W., Washington 5.)

(See issue of 16 March for comprehensive list)

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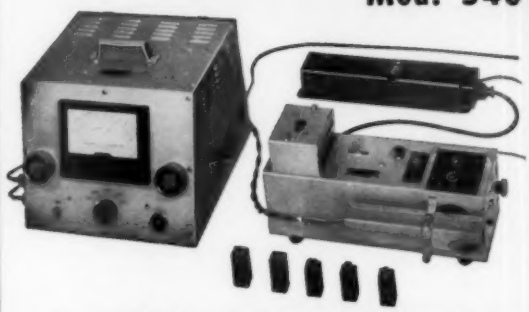

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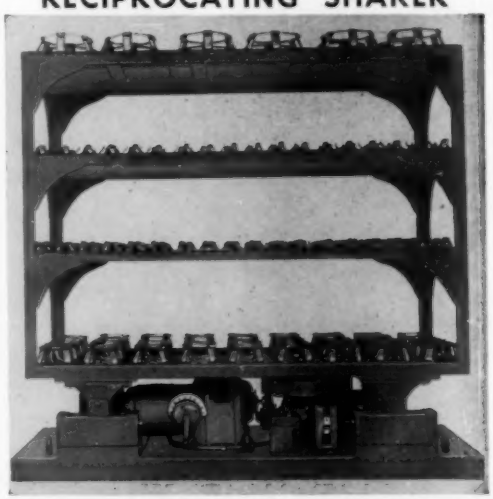

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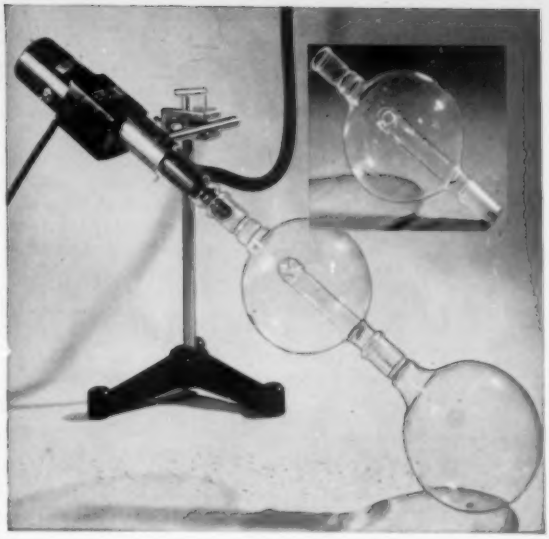

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Equipment News

■ INSTRUMENT REFERENCE MANUAL designed to familiarize laboratory workers with instrument methods of analysis is available from Coleman. This publication contains a complete description of the most commonly used methods of instrument analysis, including spectrochemistry, nephelometry, colorimetry, *p*H measurement, fluorimetry, and flame photometry. (Coleman Instrument Co., Dept. Sci., Maywood, Ill.)

■ PRECISION WASHING MACHINERY is the title of a new booklet that describes two main types of automatic and semiautomatic friction-method cleaning machines, pressure-spray jet washers, and powered out-of-water brush machines. (Southern Cross Mfg. Corp., Dept. Sci., Chambersburg, Pa.)

■ INFRARED CO_2 ANALYZER, Liston-Becker model 16, is described in a new folder. Equipment is illustrated in various operational setups and described with emphasis on its speed, specificity, and accuracy. Characteristic recording traces are included showing normal respiration, hyperventilation, breath holding, and calibration operations. The publication includes specifications and an extensive bibliography covering applications of infrared CO_2 analyzers as well as effects of abnormal CO_2 levels (Spinco Div., Beckman Instruments, Inc., Dept. Sci., 732 O'Neill Ave., Belmont, Calif.)

■ DUST-PROOF HOOD for performing operations under stereomicroscopes eliminates dust by forcing outside air through a blower system and into a plenum chamber. This blower system is capable of filtration to ½-μ efficiency and provides for external removal of filters. (P. M. Lennard Co., Dept. Sci., 196 DeGraw St., Brooklyn 31, N.Y.)

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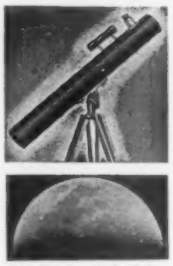

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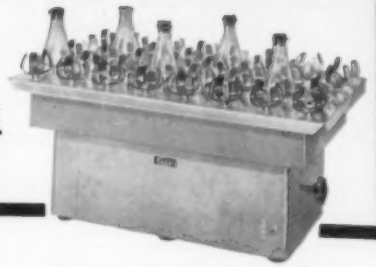

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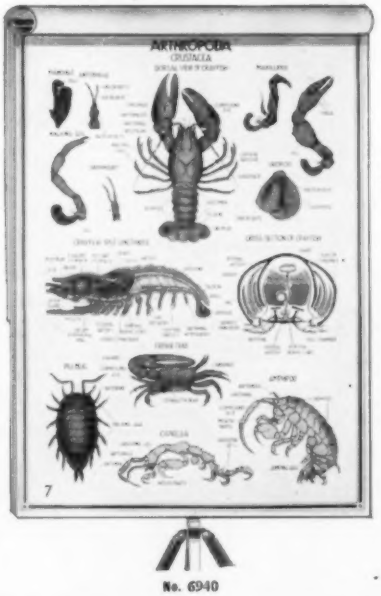

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The Meat Industry Research Institute of New Zealand (Inc.) invites applications for the post of Director. The Institute is a newly formed body and it will be the responsibility of the successful applicant to establish a research organization based on the recommendations specified in a Report submitted to the Institute by Dr. M. A. MacDonald, M.S.A., Ph.D.

Intending applicants can, if they so desire, inspect a copy of this Report, on application to the Office of the High Commissioner for New Zealand, 105 Wurtemburg Street, Ottawa, Canada; The Office of the Trade Commissioner for New Zealand, 609 Sun Life Building, Montreal, Canada; The Office of Trade Commissioner for New Zealand, 1145 Nineteenth Street, NW, Washington, D.C.; or the Office of the Consul General for New Zealand, 153 Kearney Street, San Francisco.

Applicants should have a university degree in science or agriculture. Experience in meat research and a working knowledge of meat packing plant procedures is desirable.

The appointee will be required to advise on policy, supervise research staff, disseminate research findings, and cooperate with the meat industry and other research organizations. He will be directly responsible to the Institute executive.

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All applications, which will be treated in the strictest confidence, should be posted air mail before *30 April 1956* to **Director of Meat Research, P.O. Box 345, Wellington, New Zealand.** 4/6

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Applications are invited for a position as chemical engineer to initiate engineering research on problems concerned with processing of fish and to assist in engineering work already in progress. Applicants should possess a master's or bachelor's degree in chemical engineering, and preferably possess some research experience. Send details regarding training, references, and salary required to the Acting Director, Fisheries Research Board of Canada, Technological Station, Vancouver 2, B.C. 3/23, 30; 4/6

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Berkeley NUCLEAR news notes

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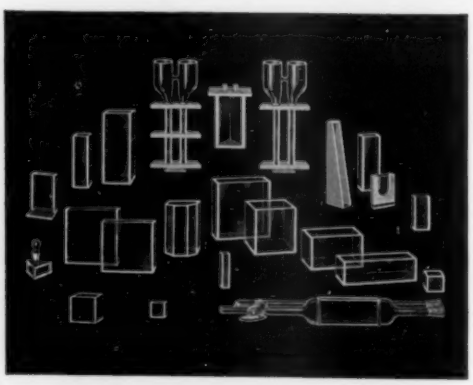

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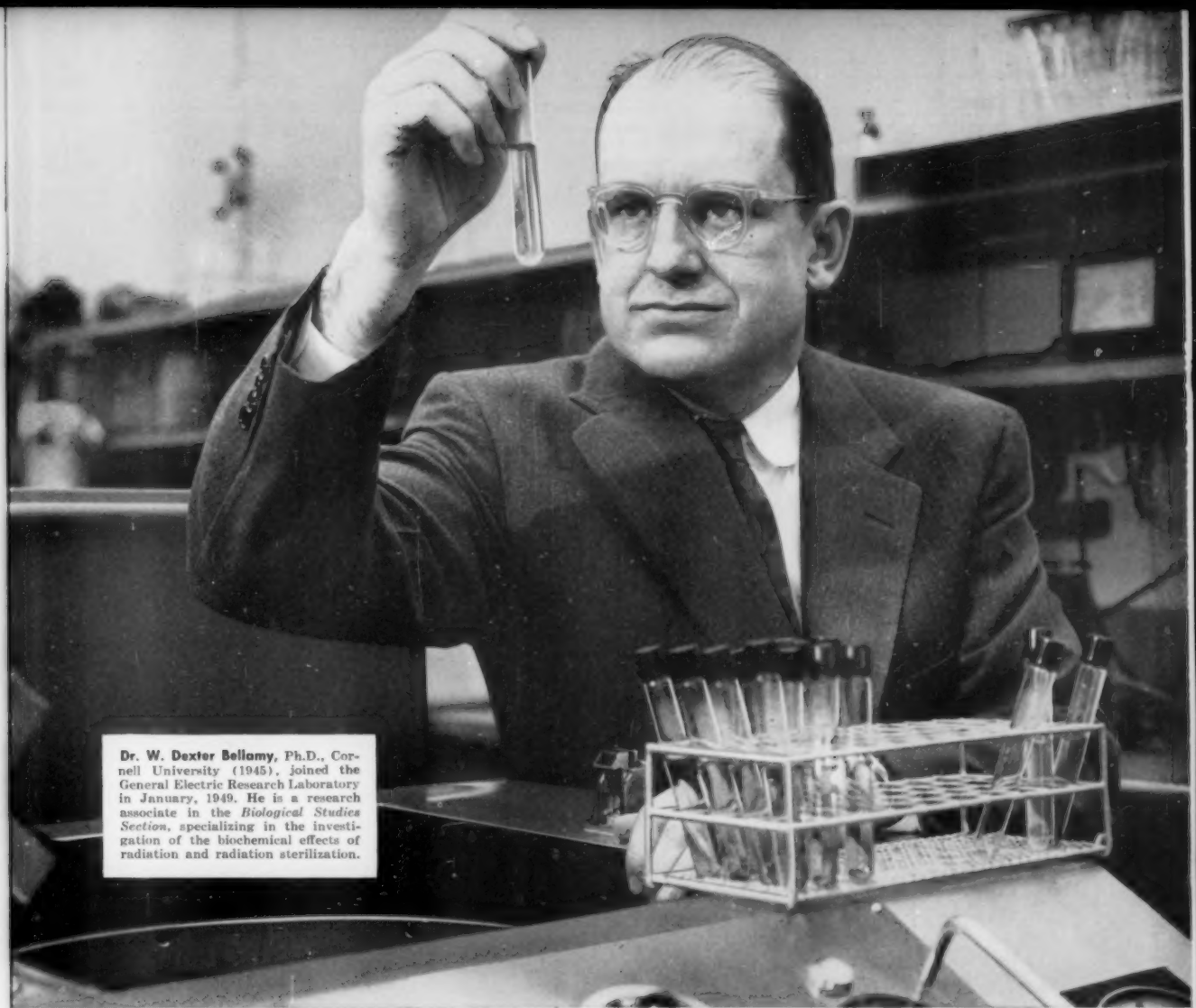

Dr. W. Dexter Bellamy, Ph.D., Cornell University (1945), joined the General Electric Research Laboratory in January, 1949. He is a research associate in the *Biological Studies Section*, specializing in the investigation of the biochemical effects of radiation and radiation sterilization.

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G. E.'s Dr. W. Dexter Bellamy finds new facts about irradiation

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